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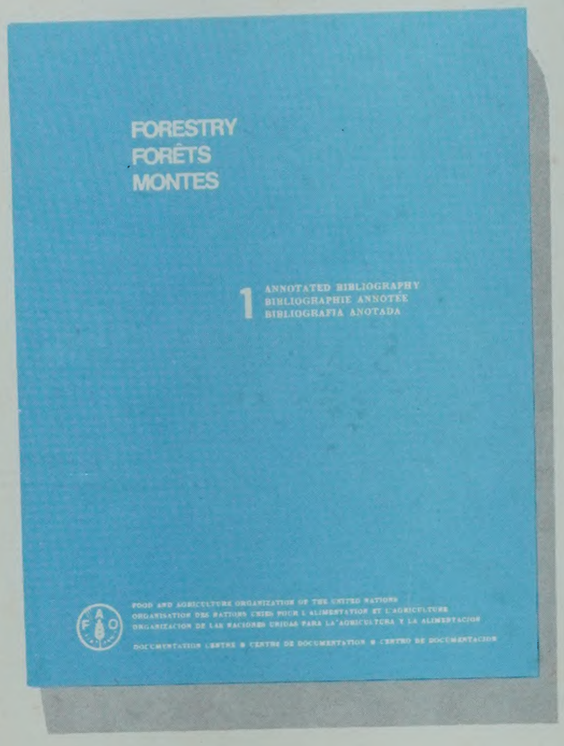

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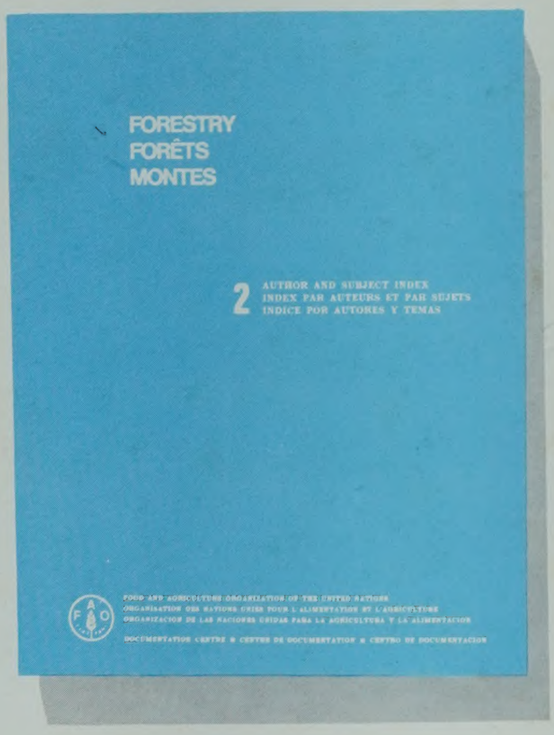

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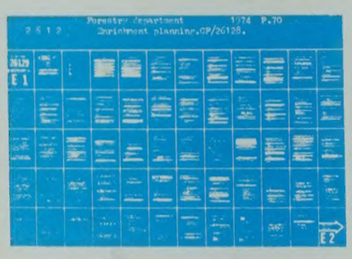

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EDITOR, T.M. PASCA

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Can farming and forestry coexist in the tropics?

John S. Spears

During recent years environmental agencies, particularly in the United States, have done a valuable job in drawing public attention to the rate of tropical forest destruction and mobilizing awareness of the need for more effective forest protection policies. During this century the area of tropical forest of the world has declined by more than a half. FAO's latest estimates expect a further 10 to 15 percent decline by the end of the century, and it is possible that, unless something is done to reverse the present trend, by the middle of the next century, the bulk of the tropical forest ecosystem as we know it could disappear. Botanists, ecologists and environmentalists have pointed out the irreversible loss to mankind which would result, citing, in particular, the loss of genetic material and the potential contribution to human welfare of drugs and medicines available from tropical woody plants. Many international conferences have been held to help create better political awareness of these issues.

However, a deliberate shift in the emphasis of conservation and development strategy is needed. If we are to ensure preservation of a significant part of the world's remaining tropical forest ecosystem, we should focus more on how to improve the incomes and quality of life of the 200 million subsistence farmers living in a state of shifting cultivation in tropical forest areas. Only the briefest glance at the history of agricultural settlement in Europe, North America and elsewhere is needed to suggest that any policy aimed at halting the present process of forest destruction while completely excluding people from the tropical forest areas is unlikely to succeed. Attacking the root cause of forest destruction — rural poverty in forest areas — and providing small farmers with a viable alternative to shifting cultivation are the key issue. An essential first step would be the recognition that a large part of the "forest destruction" taking place in tropical developing countries, which has generated such an emotional response from agencies in predominantly temperate-zone developed countries, is, in fact, a logical shift in land use to more productive agriculture.

What can be done in practical terms to make it possible for small farmers to abandon forest cutting and shifting cultivation, to adopt sustainable farming systems and to become part of more stable rural communities? What are the most appropriate choices and techniques?

A few examples of project experiences, some successful and some less so, financed partly by the World Bank may help in the search for solutions

Five World Bank projects are examined from the point of view of how they answer human needs for the kind of sustainable forestry and farming that are harmonious with tropical forest ecosystems. How can forestry benefit people as well as conserve increasingly endangered forests?
These studies are taken from Malaysia, Colombia, Kenya, Indonesia and the Philippines.

JOHN S. SPEARS is Forestry Adviser to the World Bank, Washington, D.C. This article is a personal contribution and the views expressed do not necessarily represent an official statement of World Bank policy.

for reducing the risk of continued ecological degradation.

In reviewing these project experiences, I have set up three criteria:

What impact have these projects made on rural incomes? In particular, have they been effective in stabilizing rural communities and in arresting shifting cultivation?

Was adequate provision made in project design for protection of part of the forest area or for establishment of compensatory forest plantations, and has this happened in practice?

Are the cropping patterns being developed likely to be sustainable in the light of what we know about the soil structure and capability in the forest areas being settled?

Two agricultural land-settlement projects, both of which involved forest clearing followed by, in the first case, agricultural tree cropping and in the second, livestock development, are examined below.

Malaysia: the Jengka Triangle Land Settlement Project

The Jengka Triangle in the state of Pahang covers about 120 000 ha, of which about half are considered suit-

ROAD BUILDING IN COLOMBIA
plenty of problems

able for agricultural development. The area was identified in the early sixties as favourable for large-scale tree-crop development and settlement. While earlier land settlement took place in smaller schemes scattered throughout Malaysia and close to existing infrastructure, the Jengka Triangle was to be the largest attempt at that date for the development of virgin tropical forest lands.

In 1965, a technical assistance grant was made by the World Bank to the Government of Malaysia to help finance a land-use study of the area and the preparation of a regional development plan. The "master plan" completed in 1967 called for comprehensive development of the Triangle, comprising settlement, in a first phase, of some 9 000 farm families cultivating about 40 000 ha of oil palm and rubber; systematic exploitation of forest resources prior to settlement; urban development, including the establishment of three new townships; and extensive infrastructure development.

A first Jengka Triangle Project, commencing in 1968, planted 12000 ha of oil palm and 1 600 ha of rubber. A second project, commencing in 1970, developed a further 7 000 ha of oil palm and 6 000 ha of rubber. Physical works included clearing of forest land, construction of houses, offices and stores to accommodate settler families, and recruitment of management and support staff. A palm-oil mill was constructed together with appropriate roads, water systems, and educational, health and other social services. About 300 ha were developed for crop diversification trials on a commercial scale. Each settlement comprised about 4 ha of planted oil palm or rubber, and a house lot of 0.1 ha for growing food crops. A third loan, made in 1973, will complete the programme.

According to the three criteria defined earlier, the project can be judged successful. Rural incomes of the 9 000 families settled in the first phase have shown a four-fold increase. Settler turnover rates are low (two percent) and the village communities are expected to remain stable. By careful forward planning and the carrying out of appropriate land-use and soil-capability surveys prior to settlement, about 80 000 ha of forest, comprising 60 percent of the project area, were excluded from agricultural settlement. Cultivation was confined to the flatter areas and hill slopes, and river banks were retained under forest. The higher levels of rural income and stable communities in the project area have reduced the risk of shifting cultivation and further forest destruction. Also, it seems reasonably certain that the cropping patterns developed in Jengka, based on perennial tree crops, are sustainable, given appropriate fertilizer application. The economic rates of return have been higher than expected, and Malaysia's exports of palm oil have been a very significant source of foreign exchange earnings.

On the negative side, there were several problems. Settling families had difficulty in protecting their crops from wild pig and other animals because of the close inter-relationship of forests and settled lands; attempts to increase revenues from salvage logging in the area prior to settlement, by establishing a sawmill and plywood mill, have not been very successful. Finally, controversy arose over the relatively high cost of the project (US$15 000 per settled family) and the extent to which this type of project is replicable. Lower cost criteria have now been introduced for future World Bank involvement in settlement projects.

To maintain at least part of the remaining tropical forest ecosystem intact, the Malaysian Government in 1976 created an Environmental Ministry and prepared a comprehensive environmental plan for the country, aiming at setting aside more than 1 million ha of forest as permanent biotic reserves and national parks. Of this, 0.5 million ha have already been reserved.

As a model for replication in other countries, the intensive land-use and soil-capability surveys carried out prior to the Malaysia Jengka project are particularly noteworthy. The perennial agricultural tree crops being grown provide an effective soil protection and catchment area cover, and the prospect of sustainable income for the farmers. Such perennial agricultural tree crops already cover about 25 million ha of the world's former tropical forest lands; market prospects for most of these crops are good and further expansion of something in the order of an additional 2 million ha can be expected between now and the turn of the century.

Colombia: Caqueta Settlement Project

In this project, land settlement was spontaneous, less formalized and less successful than in Jengka, and was based mainly on a livestock farming system.

Colonization of the tropical forest areas of Colombia started in Caqueta during the rubber boom, earlier in this century. In the late thirties large numbers of settlers began to move in as word spread that they could take possession of public land and that the area was very well suited for livestock. Government support started in 1959 with a directed settlement scheme organized by Caja Agraria, which failed because of poor selection of settlers and inadequate supervision of credit beneficiaries.

In 1969, the Government of Colombia requested World Bank assistance in development of a continuation of the settlement programme. A loan of US$8 million was made in 1971 for a first-phase Caqueta Project, which was to be developed over three years and administered by a new settlement agency, INCORA. It was to benefit the 8 000 settler families living in the area. The first phase provided long-term livestock loans for 4 500 settlers, construction of 380 km of roads, 90 primary schools, six health centres and improvement of INCORA's administration. Settlement costs were estimated at US$20 million.

In practice, the project suffered from a number of problems including considerable price increases in all fields, unexpectedly difficult physical conditions affecting, in particular, the road construction programme, and lack of participation by settlers in constructing schools under self-help programmes. Toward completion of

disbursement, the project design was changed and, in 1975, a second loan was made taking into account difficulties encountered under Phase I. It was concluded when defining the second phase that, while it was premature to observe any improvement of beneficiaries' incomes, the possession of a basic livestock herd had enabled participants to maintain themselves on their current holdings (averaging 85 ha) instead of continued dependence on shifting cultivation. By importing 60 percent of the breeding cattle into Caqueta, the project had "markedly improved the development prospects of an area designed to play a major role in Government's efforts to develop livestock production".

Outstanding problems, such as the lack of technical assistance to farmers, inadequacy of road maintenance, and the provision of social services were to be rectified in the second project phase.

The Caqueta project has been controversial. Kirby, for example, has commented in *Pacific Viewpoint:*

"Not only are most farmers operating a farm unit smaller than that regarded as viable in a beef breeding/fattening economy, but that the tendency toward a bimodal structure is accentuated by the inability of small farmers to buy cattle. Credit is available for the purchase of foundation stock, and, with an inflation rate of more than 20 percent, credit bears a negative rate of interest of 12 percent per annum after a three-year grace period. But new colonists are very wary about credit for cattle purchase, for, if animals die, or are rustled, the loan must still be repaid. Credits for land clearance or pasture are rarely sought since the value of the improved land will be directly dependent on grazing animals not necessarily available to offset its cost. In addition, the Caja de Crédito Agrario has an understandable tendency to lend money to established farmers, where supervision is easier and repayment guaranteed by the collateral security of an existing herd. In summary, the situation in Amazonia is one of very slow improvement in the lives of the new settlers. In 1971, only 55 percent of Medina's sample, in Caqueta and Putumayo, would have stayed on their farm if the possibility existed of their moving elsewhere. For the majority, life is one of shifting cultivation of subsistence crops, living on informal shopkeeper credit."[1]

It would be premature to draw any firm conclusions about the project's possible long term impact on rural incomes. But this project does highlight the major issue concerning planned settlement in the Latin American tropical forest regions — that of the extremely poor quality of some of the forest soils and the difficulties of ensuring sustained livestock and crop production. Much publicity has been given to the degradation of former tropical forest lands in Brazil, caused, for example, by badly managed livestock schemes. By contrast, Sanchez has presented a body of evidence from trials carried out by the Centro Internacional de Agricultura Tropical, Cali, Colombia (CIAT),[2] and other agencies that, given appropriate fertilizer treatment, stocking density and agronomic management, a considerable proportion of the acid latosols of the Amazon region is capable of sustained agricultural crop or livestock production. Several fairly large-scale pilot programmes are under way, the results of which could be highly significant for future development in the Amazon region.

The World Bank's new forestry lending policy stresses watersheds, energy reforestation and smallholder cash-crop tree farming.

Regarding the extent of adequate provision for protecting the forest resources in this settled area, the Caqueta Project experience was an acknowledged failure. At the outset of the project, a deliberate attempt was made to set aside an area of 20 000 ha as a permanent forest reserve, but within a year, despite expenditure on forest guards' housing and protection services, the area was invaded by colonizing families.

To ensure an adequate supply of fuel, building poles and timber for incoming settlers and to maintain the protective role of the forests, the Caqueta Project area which was originally part of an officially declared "Amazon Forest Reserve" was made the target of special resolutions [3] aimed at ensuring that colonization should take into account the need to preserve the forests. The law required recipients of more than 50 ha of public lands to keep 20 percent under forest and it allowed the Government to maintain 10 percent of the area as a protective zone. In practice, the farmers' obligation under this law proved impossible to enforce; the experience on fully developed farms showed that, on average, settlers would maintain not more than five percent of their land under forest for the protection of a spring, or for the supply of housing and fencing wood.

This experience suggests the need for greater flexibility in defining forest laws which decree that an arbitrary percentage of settlement areas should be retained as forest cover, a common feature of land-settlement projects. The Caqueta farmers' decision to protect only five percent of the forest land in order to ensure basic needs for fuelwood and other forest products would seem quite rational in the light of experience elsewhere, which suggests that an average rural family might need something between 250 and 500 trees (less than 0.5 ha) to maintain basic domestic needs. The relevant point is that the main beneficiaries of the various government resolutions aimed at protecting a larger area than this would be farmers situated downstream from the Caqueta Project area, who would benefit from protection of the river head-waters, reduced flooding and sedimentation. These "external" benefits have little

relevance to farmers living within the Caqueta Project area, and it is hardly surprising that they should regard the 20 percent restriction primarily as an obstacle standing between them and the possibility of increasing family income by developing additional food cropping areas or acquiring more livestock.

The broader issue raised here is whether, in fact, retention of, say, 20 percent forest cover is the only way to ensure effective catchment area protection. While there is plenty of scientific evidence to show that undisturbed natural forests provide an optimum cover for ensuring adequate soil protection and regulating downstream flow, there is also evidence from many parts of the world, including tropical areas, that other forestry, agriculture and livestock farming systems can also provide adequate catchment protection (see Kenya project below) provided care is taken over soil conservation measures, and livestock numbers are maintained in balance with the carrying capacity of the land. Seen in this light, an alternative approach to designing the Caqueta Project might have placed greater emphasis on soil conservation measures and on the back-up extension services needed to ensure adequate husbandry practices. For protecting forests on very steep slopes and along river banks in the project area, greater flexibility in selecting areas for protection and closer consultation with incoming settlers on this aspect might have produced different results. Recently, the project's forestry component has been revised along these lines and progress is being monitored to assess the impact of these changes in project design.

A second major issue which arose during the formulation of the Caqueta Project, and which has considerable relevance to settlement schemes in other parts of the tropics, was the question of how to increase returns from logging operations prior to settlement. Before 1975, land-clearing operations in Colombia had resulted in the felling and burning of 500 000 ha of forest. At the time of project preparation, clearing was proceeding at the rate of 30 000 ha a year. Every year, it was estimated that 2 million cubic metres of mature timber were being cleared, only one percent of which was sawn and sold, and the rest burned. Of total standing biomass volume of something between 250 and 300 cubic metres per ha, only 25 trees averaging 40 cm diameter or more were suitable for processing into lumber or plywood — and of that, only 17 cubic metres were of species which were marketable. Although a further 30 cubic metres (40 percent) were suitable for charcoal burning and fuelwood production, they could not be used for this purpose because both local and nearest potential export markets were saturated. After intensive study of this issue, it was concluded:

"It is considered quite impractical, if not impossible, to rationalize felling

INDONESIAN WOMEN

five hectar

at the present stage of development of the Caqueta Project. Whatever benefits could be obtained from a rationalized forest exploitation should be weighed against the delays it would cause in developing the area through spontaneous colonization. The studies carried out show that, under these conditions, rationalized forest exploitation would not be economic".

NSMIGRATION PROJECT
d per family

Kenya: the taungya system

Kenya's plantation forestry programme has a number of features of general interest including the role which plantations could play in reducing pressure on the natural forest ecosystem; the provision for the setting aside of specified nature reserves; the fact that some of the past shift in land use from forestry to agriculture was based on systematic long term catchment area studies of the likely impact of different cropping patterns on stream flow and downstream agriculture.

Kenya's forests cover about 2.5 million ha (about four percent) of the country's total area (16 percent of the land area receiving more than 850 mm of rainfall). Over the past 50 years, the indigenous forest has been continuously exploited for the production of sawntimber and other forest products. Because natural regeneration of indigenous forest species takes between 60 and 100 years to produce timber of usable size, the Government, over the last 30 years, has been replacing some of these forests with faster growing exotic softwood plantations. To date, a total of about 160 000 ha of industrial plantations have been established, representing seven percent of the total forest area.

In 1969, the World Bank made a loan of US$2.6 million to finance part of the costs of a six-year time-slice of this plantation development programme. The aim was to es'ablish 28 000 ha of plantations during this period and it was successful in meeting the target. In 1976, a second loan of US$10 million financed the continuation and expansion to cover the whole of the industrial plantation programme of the Forestry Department. This project is due for completion in 1980 and a third phase will, simultaneously, concern rural afforestation and industrial capacity needs for processing the expanding raw material base.

Most of Kenya's afforestation programme has been carried out using the "taungya" system. In Kenya, forestry workers grow mainly maize, beans or potatoes for a period of four or five years, after which the plantation is grown on as a monoculture forestry crop until ready for harvesting. Pines and Mexican cypress were the main species used.

With respect to the three main criteria used in this paper the project can be regarded as successful. The forestry plantation programme provides sustained employment for some 5 000 persons. Kenya's forest villages,

more than 100 of which have been established over the last 30 years, sustain stable forest communities dependent on a combination of agriculture and forestry work for their livelihood. Many of the forestry workers are second-generation forest villagers. As the forestry programme has proceeded, secondary employment opportunities have been generated in logging, sawmilling, pulp and paper and furniture factories.

The new forestry plantations have a wood productivity some 15 times greater than that of the indigenous forest which they are replacing. The deep volcanic soils on which the plantations are being established are capable of sustained cropping, although recent research work suggests some fertilizer application may prove necessary between rotations.

Two points of general interest arise from this project experience. The first is the role which such compensatory plantations can play in relieving the pressure on indigenous catchment protection forests. It is from the 2.4 million ha of indigenous forest that most of Kenya's important rivers and streams originate. Prior to the fifties, more than 90 percent of timber production came from these indigenous forests. Timber-concession licences had been allocated under long-term contract arrangements covering most of the accessible forest area. Today, in 1980, the compensatory plantations which have been established in Kenya — and cover less than 10 percent of the former indigenous forest area — are supplying more than 80 percent of Kenya's industrial wood demands for both domestic consumption and export. The net effect has been to reduce the intensity of exploitation in the remaining 2 million ha of indigenous forest, the primary function of which remains that of catchment protection.

The second point is that, as part and parcel of this overall forestry development programme, the Kenya Forestry Department, some 20 years ago, established 43 000 ha of nature (biotic) reserves. In the second forestry project financed in 1976, one condition of the loan was that these reserves would be extended by a further 7 000 ha, so that they would become fully representative of Kenya's biological and botanical ecosystems. This was done.

A third point of general interest relates to Kenya's enlightened land-use policies in the area of forestry. Because of intense population growth and the fact that much of the forest is situated on soils of high agricultural potential, the indigenous forest areas have always been under pressure for agricultural settlement. In the fifties, a series of long-term comparative catchment area studies was carried out by EAFFRO [4] to compare the impact on stream flow, soil erosion and

Some observations about agricul

Because of uncertainties in some of the traditional smallholding cocoa-producing countries, cocoa cultivation is becoming geographically more widely distributed and is increasingly being grown on a plantation basis, either as a monoculture or under coconuts. In Malaysia, the traditional tree fruits may follow a similar course and black pepper is also seen as a target for the specialist-producer.

This trend cuts right across the emphasis in current international forestry literature on the potential for "agri-forestry", that is, simultaneous inter-cropping of trees and food crops. It is important, therefore, to clarify the difference between these monoculture farming and forestry systems and the integrated food and tree inter-cropping farming systems practised, for example, by small farmers in Java, in the Kerala region of India, in Sri Lanka (the Kandy Garden System), and so on. The very small farmer of the humid tropics with less than two hectares of land, typically grows a variety of food and cash crops around and near his house. In Java, the farmer is highly skilled and cultivates rice, cassava, maize, beans, groundnuts and vegetables in association with bananas, plantains, citrus, cloves, cinnamon, pepper, coffee, cocoa and a variety of tree fruits, all under a thin stand of coconuts.

The homestead tree lot, so typical of the humid tropics, reaches its highest expression in Sri Lanka, where the "tree gardens" round Kandy present a complex association of cassava, bananas, ginger, plantains and others under a mixed stand of tree fruits, coffee, cocoa, pepper, cinnamon, cloves, areca palm and coconuts. In West Africa, this sector is represented and vegetables are grown in association with a mixed stand of coffee, cocoa, tree fruits, kola and oil palm.

These small-farmer systems contrast sharply with the simplicity of mono-cropped agriculture and forestry plantations and by comparison would be more difficult to modify and improve. Improvement of smallholdings such as those in Java and Nigeria may only be possible by the provision of better planting material over an extended period of time, but a catalytic effect might be achieved by better roads and marketing facilities. These would stimulate the larger and more progressive farmers into modifying their cropping systems to take advantage of the better circumstances, but for the very small subsistence farmer, the element

downstream sedimentation of alternative land-use systems, including natural forest in an undisturbed state, plantation forestry, tea plantations, livestock and intensive food cropping. It was clearly established, given appropriate soil conservation measures, planting spacement and other husbandry techniques, that tea, for example, could provide an effective catchment cover without adversely affecting downstream flow and sedimentation. This long-term experiment was used as a basis for a deliberate decision by the Government of Kenya to excise some 10 000 ha of forest land in the southwest Mau Forest for subsequent tea production. Tea exports have now grown to be Kenya's second largest export earner after coffee, generating foreign exchange earnings which account for 25 percent of agricultural exports and 10 percent of total exports. Most of the tea industry which has enabled some 20 000 farmers to move from a subsistence to a cash-crop farming system is located on what used to be indigenous forest land.

Indonesia: Transmigration II

The Indonesia Transmigration Project, as the Colombian Caqueta Project, concerns the settling of small farmers on acid tropical forest latosols. In Indonesia, the emphasis is on arable crops, whereas in Colombia it is on livestock.

As part of a long-term transmigration programme, the Government of Indonesia requested World Bank assistance in 1973 for a project to help resettle incoming families from Java and Bali on four sites along the trans-Sumatra highway in the Province of Jambi and to upgrade the standards of living of existing families already settled at a site in the same area.

The Indonesia Transmigration scheme is one of the largest resettlement programmes in the world. Since 1905, successive governments have sponsored the migration of poor farmers from the overcrowded islands to relatively under-utilized neighbouring islands, particularly Sumatra. All told, government programmes have transferred nearly a million se'tlers, and an estimated 2 million Javanese residing in the Outer Islands are there as a direct result of government resettlement and associated population growth. Much of the earlier settlement provided workers for rubber estates in Sumatra.

In January 1974, FAO undertook a study to identify a possible transmigration project suitable for external assistance, and in 1976, based on the results of this study, the World Bank undertook a first-phase transmigration project intended to upgrade the living standards of 12 000 settled families and to establish a new community for

al plantations and agri-silviculture

of risk could still be too high to permit change; under these circumstances, some degree of land consolidation and cooperative farming might be essential before improved cropping systems could be introduced.

As a broad conclusion, it seems that the "agri-forestry" farming systems used by small farmers in Java and elsewhere in the humid tropics are well proven and provide a diversified combination of subsistence, food and cash crops which reduce the risks of starvation and, at the same time, offer some small surplus cash income. However, it seems possible that where small farmers have room to manoeuvre and expand the scope of their cash-cropping operations, the trend is likely to be toward monoculture rather than away from it. In other words, in the humid tropics agri-forestry combinations may not always prove to be the most productive small farms.

The distinction between monoculture and intercropping (agri-forestry) farming systems deserves attention because recently there has been a tendency for foresters to jump on the agri-forestry bandwagon and promote indiscriminately agri-forestry systems in all areas of forestry development as a means of increasing the productivity of tropical forest lands. A more selective approach seems to be warranted with emphasis on those small farming systems or phases of development in plantation forestry where intercropping of food and tree crops can be of definite technical and economic benefit.

An associated issue is this: if we take a closer look at the potential for introducing agri-forestry in the humid tropics outside the well-established taungya plantation model and study the cropping pattern being used in such places as Java, Kerala, and Sri Lanka, we find that most of the trees which are being grown are fruit trees or horticultural crops which traditionally have fallen outside the foresters' province. Clearly, if foresters are to play a more active role in this area, we need to broaden our knowledge of the range of tree crops which can be used in forestry and to work in closer association with tropical agronomists who are familiar with such crops. We will also have to accept that this is an area in which the forester may often have to play a supporting role to the agronomist and agricultural economist rather than the converse. Investment in traditional forest tree crops will frequently, but not always, be a relatively low proportion of the cropped area and of farm investment costs.

4 500 new settlers. New migrants were provided with five ha of land, of which 0.5 ha was already cleared and 1.0 ha already planted to immature rubber. A second-phase project is now in progress, building on the experiences gained. A smaller farm size (3.5 ha) is being adopted.

The most controversial issue has been the question of the sustainability of the cropping pattern, taking into consideration the highly acid nature of the forest latosols, deficient in nitrogen and phosphorus and possibly low in potassium. Earlier research showed that soil structure is favourable to plant root formation and that by adding regular fertilizer inputs some of the forest soils would become suitable for upland food crop production. To combat the high phosphate fixation, the initial phosphate application should be heavy. Nevertheless, no technical package involving a high degree of dependence on annual food crops has yet been proved over a long period of time.

The cropping pattern originally envisaged under the project allocated 3.5 ha of land per family, of which two ha were for food cropping and about 1.5 ha for tree crops (mainly rubber), the latter to be grown as a monoculture. Land clearing was to be carried out by a combination of mechanical and hand methods and 500 kg per ha of rock phosphate harrowed into the soil just prior to settlement. The main food crops to be grown were rice, maize and cassava and it was assumed that settlers would establish house gardens containing vegetables and tree crops such as coconuts, cloves, coffee and bananas and different fruit trees. Special provision was made in project design for ensuring that farmers would have adequate supplies of fertilizer, that there would be a framework for close coordination of the various government agencies involved in providing extension support, and that seed and planting materials would be readily available for the farmers as and when needed. A staffing ratio of one agricultural extension worker per 500 families was planned (higher than in similar projects elsewhere), as well as a strong emphasis on training.

Despite these provisions, a recent review of project progress has highlighted the fact that incoming settlers are having difficulty in producing enough food crops to ensure subsistence and in securing the necessary inputs, such as fertilizer and improved seeds.

The key policy issue is whether there is any practical alternative to forest settlement in Indonesia in the light of increasing population pressure on the limited areas of good soil. The "alang-alang" grassland [5] areas and the "Cerrado" region in Brazil, for example, could in theory provide a short-term alternative to continued forest settlement and allow more time needed to develop sustainable farming systems for the tropical forest latosols. However, in practice, a sustainable farming system for the "alang-alang" grasslands has not been developed. The scope for more intensive research in this area is a matter of high priority.

The question has sometimes been raised by environmental and other agencies as to why the World Bank supports such settlement projects in situations where there are significant ecological risks? Part of the answer is that spontaneous settlement as a result of population pressure is a fact of life in many tropical situations, has been going on for many years and in some cases is beyond government control.

By actively working toward improvement of existing farming systems, upgrading of extension services, assurance of a ready supply of agriculture inputs, and supporting more intensive agricultural research, the chances of preventing ecological degradation should be enhanced. The alternative — allowing spontaneous settlement to proceed unchecked — would leave farmers with inadequate inputs, and without extension services, roads, social services and marketing and other facilities.

As was noted earlier when dealing with the Malaysia Jengka project, it seems important to keep in perspective the fact that part of the remaining tropical forest ecosystems could be put to more productive and sustainable land use, for example, by converting it to perennial agricultural tree crops and thereby providing thousands of small farmers with a viable alternative to shifting cultivation.

Philippines: a smallholder tree-farming project

The unique feature of this smallholder tree-farming project is that, with the exception of a project in Gujarat State, India, it is the only one financed by the World Bank, to date, where small farmers are growing forest trees as a cash crop. This is a second-phase project and it has two main components: smallholder tree-farming through a supervised credit scheme operated by the Development Bank of the Philippines; and pine plantation development by the Bureau of Forest Development.

The smallholder tree-farming component is encouraging farmers on marginal agricultural lands throughout the country to take up tree farming (associated with food crop production) for establishment of firewood, charcoal, pulpwood and leaf-meal plantations. The project is innovative and experimental and is based on the Bank's experience of an earlier US$2 million pilot project which provided funds for the development of pulpwood resources around the PICOP Pulp Mill. The first-phase pilot project was successful and has led to a quantified and readily perceivable improvement in the participating farmers' income and way of life.

Under the second-phase project, out of 28 000 ha of tree-farm development to be financed, 10 000 ha will be located in Mindanao, 5 000 in Visayas and 8 000 ha in the Ilocos region of northern Luzon. Tree-farm size ranges from two to 15 ha. Fuelwood and charcoal plantations, which account for a high proportion of project farms, average about five ha.

In relation to the likely impact of the project on rural incomes, experience under the Philippines I Project is well documented and it would seem reasonable to anticipate sustainable net revenues of something between US$78 and US$100 per ha from tree farms of *Albizia* producing pulpwood, something in the order of US$140

per ha for tree farms producing fuelwood and charcoal, and US$300 per ha for farms producing leaf meal (based on Giant *Ipil-ipil*).

The financial rates of return to farmers are high and the project's economic rate of return is something in the order of 23 percent. The second project is experiencing difficulties related to land-tenure constraints, and the need for greater flexibility in this area is under review.

As for ensuring that forests are protected, the most interesting feature of the Philippines smallholder tree-farming experience is that it is mobilizing shifting cultivators in the re-establishment of forest cover in formerly degraded catchment areas. The profit incentive of tree farming is helping to encourage reforestation of eroded catchments.

Despite the obvious attraction of this formula, there are limitations to its wider application. One of the main problem areas in planning for expansion of the first-phase project proved to be the economic radius for haulage for pulpwood. Smallholder tree farmers situated outside a 100-km radius from the mill were excluded because of the transportation cost factor. Projects of this type are particularly suitable for establishment of plantations around a central processing plant (whether for the production of pulp, charcoal, power generation, alcohol, lumber or leaf meal) where there is a guaranteed market price for wood. But all of these different industries have upper limits of delivered wood cost beyond which it is not possible, profitably, to process the raw material. In other words, they are primarily suitable for concentrated resource development within the command area of a processing plant. For this reason, this approach could not be adopted as a "blanket" solution for all proposed forest areas in which shifting cultivation is a serious problem.

The scope for extension of the Philippines experience to other countries is, nevertheless, considerable and the World Bank is reviewing prospects for helping some of its other member countries to undertake similar schemes.

One of the most effective ways to slow down the rate of tropical forest destruction is to attack the root cause of the problem — rural poverty. If we continue to depend only on exhortations to logging companies, multinational corporations and developing-country governments to "stop tropical deforestation", it is my own personal view that we will be no more successful in arresting the pace of forestry destruction than was King Canute in trying to stop the advancing waves by using equally futile tactics. A deliberate shift in conservation strategy is needed to focus more on positive approaches to rural development and alleviation of rural poverty, if we are to preserve effectively what is left of the tropical forest ecosystems.

To save the tropical forests from further depletion the focus should be more on how to improve the incomes and quality of life of the 200 million who practise shifting cultivation throughout these forests.

I have attempted to show that a considerable part of the so-called "forest destruction" taking place in the developing world is, in fact, a logical shift in land use to more productive crop or farming systems. Provided that these are adequately supported with technical extension, agricultural inputs and other resources, land-settlement projects can provide a sustainable land-use alternative to retention of the land under virgin forest cover. There seems to be convincing evidence that many of the agriculture and rural development projects already initiated in tropical forest areas have resulted in a quantifiable increase in rural incomes; have enabled the small farmers involved to settle in more stable communities; and have eliminated their former dependence on shifting cultivation. In other words, settlement of small farmers and forest protection need not be mutually exclusive objectives.

In some of the projects undertaken in the past in which land-use and soil-capability surveys were carefully carried out in advance of settlement, and agricultural development channelled into the flatter lands, it has proved possible to exclude a large part of the remaining forest from agricultural settlement and this has remained unexploited (Malaysia, Jengka). In other cases, inadequacy of forward planning, or too high a degree of dependence on non-enforceable forestry protection legislation, has failed to protect the forest. This means that project design must be flexible and take into account the needs and aspirations of incoming settlers or small farmers (Colombia, Caqueta).

Because of the wide variation of tropical forest soils, climatic and physical conditions, it is impossible to generalize about appropriate farming systems for tropical forest areas, but what seems to emerge from this analysis is that perennial agricultural tree crops such as oil palm, coffee, rubber, cocoa, tea and coconut can be an ecologically sound alternative to natural forest management and, secondly, that whatever agricultural crop or livestock or forest plantation crop combinations are envisaged, the capacity of governments to ensure adequate support services, inputs, such as fertilizer and seeds, agricultural research services, feeder roads, social infrastructure and marketing outlets constitute a decisive factor in determining whether a particular farming system is sustainable. Even in the most intractable soils, such as those of the Amazon, evidence suggests that, given appropriate attention to soil conservation measures and crop husbandry techniques, it may prove possible to sustain arable, and even livestock farming, systems on at

least the better endowed of these low-fertility soils where, in the past, all such attempts have failed.

Because market constraints for plantation-grown agricultural and forest tree crops will probably limit their development to something less than 10 percent of the remaining tropical forest ecosystems between now and the turn of the century, high priority should be given to agricultural research and to pilot-scale development programmes aimed at improving the present state of knowledge of sustainable food cropping systems as an alternative to shifting agriculture and, in the interim, directing settlement to better soils.

In watershed areas, an integrated rural or "area" development approach which offers the small farmer an alternative to his ecologically destructive way of life can help to preserve the remaining forest and, thereby, reduce the risk of soil erosion and downstream flooding. Investment in such infrastructural "inputs" as a supply of seeds and fertilizers, torrent-control structures, soil-conservation measures, provision of credit, training of extension staff, feeder roads, marketing services, schools, shops, hospitals and other social services is the quickest and most certain way to ensure that farmers abandon shifting cultivation and adopt a more sustainable farming system. Some agricultural and livestock farming systems with appropriate husbandry practices can also provide effective catchment protection. In other words, forestry is not the only solution.

It is clear that compensatory forest plantations have an important role to play in ensuring protection of part of the remaining tropical forest ecosystem because they can provide an alternative source of timber and take the pressure off further exploitation of indigenous resources. Reforestation programmes in the developing countries are currently proceeding at less than 20 percent of the rate needed to ensure domestic self-sufficiency by the year 2000 and a massive increase in the annual rate of establishment of fast-growing species is called for before smallholder tree-farming can play a significant role in situations where the forest lands or catchment areas to be protected are situated within an economic haulage distance of a processing plant or cash market.

Concerning the problem of the preservation of biotic reserves, the environmental agencies of the world have done a masterly job in alerting international awareness on this matter. It is becoming widely accepted that the arguments in favour of preservation of forest-dwelling hunter/gatherers, wildlife, botanical genetic resources and potential future drug and medicinal plants are irrefutable and the governments of some developing countries (e.g., Malaysia and Kenya) have expressed their willingness to increase efforts to protect such resources and have created environmental agencies. But the only certain way we have of ensuring that these designated biotic preserves will be protected in practice is by increasing support for rural and agricultural development programmes in adjacent areas.

Foresters might regard some of the projects described here as agriculture rather than forestry projects, and it is precisely at that point that problems can arise. Foresters in the past, have tended to be highly parochial about defining what constitutes a forestry project and to assume that their responsibility starts and ends with the cultivation of forest trees in forest reserves. In fact, forestry investments are likely to comprise a relatively small proportion of many of the rural and agricultural development projects which will be needed to bring the current process of tropical deforestation under effective control. In the area of catchment and agri-forestry, in particular, foresters will have to be prepared to work more closely with agricultural settlement and other agencies, playing a complementary and supporting, rather than a predominant, role in the development process.

Concerning the World Bank's role in forestry projects, we are conscious of the fact that the Bank's efforts in this area can only be marginal and that the main impetus must come from within the developing countries themselves. Following publication of a Bank Forestry Sector Policy Paper in 1978, the Bank made a major shift in emphasis of forestry lending toward environmental and rural forestry, and set as a goal a five-fold increase in the level of forestry lending to achieve a target of US$500 million within the five-year period 1979-83. The response of the developing countries' forestry services has been encouraging. Since 1978 we have made loans to forestry projects in about 35 different countries, and more than 60 percent of these have been for programmes aimed at environmental protection and provision of fuelwood, fodder, building poles and other forest products needed both for basic subsistence and development. The US$500 million lending target has been achieved somewhat ahead of schedule.

In future forestry lending, we intend to give special emphasis to watershed protection, renewable energy-related reforestation programmes with fast-growing species, and to smallholder cash-crop tree farming in rural areas. Of the US$3 thousand million a year which the Bank is currently lending for agriculture and rural development, part will continue to be directed toward agricultural settlement and watershed protection. Although primarily aimed at reducing rural poverty, such settlement projects should make a contribution to preserving part of what remains of the world's tropical forest ecosystem. ■

Footnotes

1. See "Land use in Amazonia." *Pacific Viewpoint* (19), 1978.
2. See *Pasture production in acid soils in the tropics.* CIAT, 1978.
3. See Nos. 015 of 1963, 141 of 1964 and 216 of 1965; and articles 14 and 15 of Special Decree 2278 of 1953.
4. East African Agriculture and Forestry Research Organization located in Nairobi, Kenya.
5. Forest lands formerly under shifting cultivation now abandoned and which have reverted to a coarse grassland.

Small-scale mills for developing countries

Creating appropriate technology

A.J. Leslie and Börje Kyrklund

The most obvious way for a country to avoid getting hurt by the shortage of an essential commodity is to produce that commodity itself. The possibilities of doing so with paper in developing countries have therefore become the major item in the FAO programme for pulp and paper. During the programme's evolution, it became evident that one of the major obstacles to the establishment of pulp and paper mills in developing countries is the nature of the technology of the industry.

The development of pulp and paper technology is now virtually confined to the industrial countries and it reflects changing economic and social conditions in those countries. Three of the influences which have played a major part (until quite recently, at least) in shaping that technology are:

(*a*) The rising real and relative cost, in the broadest sense, of labour.

(*b*) The rising cost of raw materials and, in particular, wood.

(*c*) The need for industries to find ways to absorb the full cost of pollution control.

Rising labour costs have been countered by substituting capital equipment, material costs by the evolution of high-yield pulping methods and processes using other raw materials, and pollution costs have simply had to be absorbed by increasing the capital investment. The result, on the whole, has been a steep increase in the capital cost of a plant of a given capacity regardless of the process involved. Since economies of scale are an important characteristic in the financial viability of the pulp and paper industry, the minimum economic size of a mill has therefore increased tremendously.

Generally speaking, the prospects for a pulp mill in a developing country have been assessed in terms of transferring current technology. Very often and, in fact, almost inevitably, in most developing countries it was found that the minimum economic size of a mill would have a capacity much greater than the size of the domestic market or any possible regional market, and would demand a much greater capital fund than the country could afford. However, a plant with a smaller capacity, more appropriate to the local conditions, would, almost by definition, have a unit production cost very much higher than the world market prices.

The obvious alternatives in such circumstances are to establish a subeconomic mill made viable by direct or indirect subsidy, or to abandon the idea of domestic production. Neither of these is particularly attractive. The dangers of a plant depending for economic survival on a permanent subsidy are only too obvious, but to depend permanently on imports leaves the country in exactly the position from which it was trying to escape. Therefore, the idea developed of searching for another alternative, a more appropriate technology.

Technology originating in industrial countries is designed to economize on two inputs, labour and wood, which many developing countries have in surplus; and to substitute capital and highly skilled professional management, which in developing countries are usually in short supply. The pos-

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A.J. Leslie and Börje Kyrklund are, respectively, Director of the Forestry Industries Division and Chief of the Pulp and Paper Branch in the FAO Forestry Department. This article originated as a paper presented to the 21st session of the FAO Advisory Committee on Pulp and Paper held in Rome in June 1980.

sibility of designing mills which would match the market capacity and the economic situation in a developing country has, therefore, an irresistible appeal. The technical difficulties are small, since the need is little more than the re-creation of a type of industry that was successful in the developed countries in the past. Whether this can be done in a way to meet the quality standards required by today's paper-using industries is another matter.

A similar problem had been encountered more or less simultaneously in the wood-based panel industries. Because the physical processes involved are rather simpler than in pulp and paper, the capital investments are of a much smaller magnitude. Thus, fairly rapid progress was made in building up an FAO portfolio of small-scale forest industries for developing countries, mainly in fibreboard and particle board. The success of that programme in adapting modern plant design to labour-intensive, smaller-scale operations without sacrificing quality or viability provides an encouraging precedent for the small-scale mill programme for pulp and paper.

PPIDP

FAO's first effort in promoting a small-scale pulp and paper mill approach came with the establishment of the FAO/UNDP Pulp and Paper Industries Development Programme (PPIDP) in 1976. Combining the financial resources of PPIDP with the human resources of that programme and the FAO Regular Programme, a case study was formulated and subcontracted to a consulting company. The study investigated the production of cultural papers (newsprint and wood-containing printing and writing papers) on two different levels — 18 000 tons per year and 36 000 tons per year. It concluded that the production of such grades of paper on a scale as small as 18 000 tons per year could not be financially viable without subsidies. Fewer subsidies would be needed with the production of 36 000 tons of paper.

The design concept of this study was later applied to techno-economic studies for specific sites carried out by the Pulp and Paper Branch in cooperation with PPIDP. From these studies it was concluded that small-scale production of wood-containing cultural papers could be viable under certain conditions, especially if it were integrated with mechanical wood industries or with a larger pulp and paper producing complex making industrial grades of paper as well.

The conclusion from further techno-economic studies carried out in the same context was that mechanical pulping processes might provide possibilities for viable manufacture of certain grades of paper on a comparatively small scale in developing countries. The prerequisite was that simple and straightforward equipment should be used in the paper-making process. Still unsolved, however, is the problem of reducing the minimum viable size of a chemical pulp mill for manufacture of other grades of paper.

Since advances cannot be made on these problems without assistance from the industry, a correspondents' group on small-scale pulp and paper manufacture was established in 1978 with FAO as the focal point. The members of the group were recruited mainly from the FAO Advisory Committee on Pulp and Paper. The purpose of the correspondents' group is mainly to serve as a forum for exchange of ideas in the broad sense and to provide constructive criticism on ideas originating from within the group or from outside.

Cooperation

In the autumn of 1978 the Swedish Industrial Development Authority offered to finance a major techno-economic study into the viability of the manufacture of wood-free printing and writing papers at an output level of 35 000 tons per year. The contract was granted in 1979 to Jaakko Pöyry International and the final report was submitted in early 1980. The conclusion, which considered pre-engineering-level mill design, was that a simple mill designed to maximize the use of materials available locally and with a process concept of minimum sophistication could be financially viable without subsidies. On the other hand, a mill of the same size, designed according to the latest technology and using sophisticated equipment, would run at a loss under the same conditions. In both cases a fibrous raw material base of plantation eucalyptus was assumed. Since chlorine dioxide would not be used for bleaching in the simpler mill, the printing and writing products would necessarily be of a lower quality, though fully adequate to meet comparatively high demands.

Another study, financed by Finland-Aid and carried out by the same consulting company, concerned manufacture of thermomechanical pulp integrated with a sawmill and a plywood mill. The study was far less comprehensive and will be included in the FAO portfolio of small-scale forest industries. The pulp production in this case was about 16 000 tons per year (on an air-dry basis). The mill did not have any pulp drying or wet lapping facilities, but it was assumed that the pulp would be pumped to a nearby paper mill which would buy its entire production. The output from the sawmill and plywood mill would be 12 000 cubic metres and 6 000 cubic metres per year respectively. Under the conditions assumed, the integrated complex would be financially viable without subsidies.

Research

One approach in developing small-scale pulp and paper mills is to try to find new pulping processes that are less capital intensive than existing ones. Although full-scale implementation of such new processes in developing countries lies in a distant future, it is still important to follow trends and developments in this field. Some of these new processes are still only being looked at in the laboratory, whereas others, such as sulphur-free chemical pulping coupled with a fluidized bed recovery system and autocausticizing, are already reaching the pilot plant stage.

One process often mentioned as ideal for small-scale pulp production is nitric acid pulping. A very thorough pilot plant study was made of this process by the Stanford Research Institute in California in the fifties which concluded that it was not viable under conditions prevailing then. But FAO has received from the person who conducted the earlier research an updated review of his findings with cost estimates based on US conditions in 1979. According to this study, the nitric acid process would still have to reduce its operating cost considerably before it could be considered viable.

Finally, there is the pressurized groundwood process. FAO made a preliminary study of the financial implications of applying this process to newsprint mills in developing countries. Based on the still somewhat incomplete information available, it can be said that the introduction of this process, coupled with thermomechanical pulping using chips from an integrated sawmill, might be viable for newsprint manufacture on a comparatively small scale under appropriate conditions.

Objectives

The studies mentioned here are, of course, case studies based on price and cost conditions which may vary considerably from one location to another. The mill concepts accordingly should not be seen as standard solutions applicable in any developing country. It goes almost without saying that the technology of any small-scale mill has to be compatible with the social, economic and technical environment of the developing country where it is to be built. A further complexity arises from the fact that there are several types of fibrous raw materials which can be used for pulping. There are also different kinds of pulping processes and a great number of different paper grades. This underscores the point that it is unlikely that a standard solution can be found for a small-scale pulp and paper mill which would fit any raw material, any market situation, or any social and economic environment.

Based on the general ideas expressed above, the Pulp and Paper Branch of FAO has formulated the following immediate objectives for the development of small-scale pulp and paper mills:

1. To identify equipment manufacturers who are willing to direct part of their development work toward design and manufacture of equipment which would be comparatively simple, easy to operate and maintain, and which would have a range of adaptability to various levels of technical development in different countries.

Where small-scale mills are concerned there are no standard solutions. The technology has to be tailored to the country's social, economic and technical environments.

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2. To identify alternative partial process design solutions and work out in detail the design of these alternatives in cooperation with engineering companies.

3. To follow closely the progress of development work in the field of new pulping processes with a view to identifying those which might allow establishment of viable small production units, adaptable to the conditions in some developing countries.

4. To study the techno-economic implications of the various technical solutions arrived at under objectives 1, 2 and 3 and especially to establish under which sets of conditions the solutions would be applicable and would contribute to the overall solution to the problem of establishing viable small-scale pulp and paper mills suitable for developing countries.

5. To disseminate the information obtained in the activities, aiming at achieving the above immediate objectives.

Future

The activities envisaged for the future would be very similar to those carried out so far, and could be grouped as follows:

1. Develop, in cooperation with equipment manufacturers and through subcontracting to engineering firms, alternative partial process designs which would seem to provide appropriate technology for pulping and paper making under various sets of environmental conditions.

2. Through subcontracts to research organizations, obtain studies of the influence of the changes made in process design on the quality of the product and of the possible interference with other parts of the pulping and paper-making process.

3. Apply the various solutions arrived at to the conditions in different developing countries where a preliminary sensitivity analysis indicates that the technology may be suitable so that its applicability under such conditions can be confirmed.

4. Disseminate the findings arrived at, first to the correspondents' group of FAO for comments and feedback, and then to a wider audience.

5. Provide advice to governments planning to build pulp and paper mills that will give them the widest possible range of mill design and capacity choice to fit into the economic realities of their country.

The question is, of course: how can these activities be financed? ■

Arid-zone forestry

Where there are no forests and everything depends on trees

B. Ben Salem

Both theory and practice show that in areas with a long dry season, even those which are nearly deserts, natural woody formations and perennial plants make the best use of the soil and climate. In addition to their capacity for self-protection and biological improvement of the environment, they also afford protection for more modest plants growing under their shelter. The supreme example of a plant which is both woody and perennial is the tree. Trees, so often relegated to the most mediocre soils or cultivated only as a subsidiary activity, have an essential, if not preponderant, function to perform in semi-arid and arid zones. They should provide the framework and even, in some cases, the very basis of the rural economy.

The arid lands in the warmer climates of the world are generally characterized by low and erratic precipitation, diurnal fluctuations in air and soil temperatures and low humidity, although dew may contribute substantially to available moisture in certain seasons. Winds may be strong, days very bright and sunny and extended periods of drought are unpredictable, but inevitable. This means that such lands have a low threshold of susceptibility to misuse. When basic thresholds of resource tolerance to human and animal pressure are exceeded, the result is either deterioration or destruction of the physical environment with proportionally adverse effects on the rural population.

The primary reason for the massive human tragedies that are so common in arid and semi-arid regions is essentially land misuse under the marginal and fluctuating climatic conditions particular to these areas. Successful rehabilitation and improvement of the land require elimination of abuses by man. The starting point for improvement of agricultural productivity in arid and semi-arid zones should be integrated planning in which the real nature of the land and the real nature of the people who are a part of that land are taken into consideration.

One of the most common and unrecognized misuses of arid and semi-arid ecosystems involves the cultivation of annual plants without conservation measures.

Annual plants degrade soil fertility and are marginal for two reasons. First, the position of their root systems in the upper layers of the soil exposes them to the risk of desiccation, and second, because of the unreliability of the climate it is impossible to respect their specific requirements which are sometimes very strict with regard to installation, growth and maturation. Moreover, owing to the unreliability of the climate and the very nature of annual plants, the soil remains without protection and becomes exhausted during both the growth of the plants and the dry season. When planted with annual crops, arid and semi-arid ecosystems that are inherently marginal pass quickly from a state of fragility to one of total exhaustion. In other words, they are not being used in the way they were meant to be used. Sedentary and stable forms of agriculture are simply not feasible with the introduction of exotic annuals.

With perennial plants the situation is immediately different. Their growth does not depend on rain starting within two weeks of a certain date. Moreover, they cover the soil better and last longer, a trait which represents a step forward in the stabilization of the communities and of the environment. Whether natural or introduced, perennial woody plants are more profitable than the annuals, since they can provide a whole range of products: fodder, wood, minor products, even food for people and animals. First in importance among the perennials are trees of all kinds — fruit trees, semi-forest and forest trees — which are able, owing to their diversity, to adapt themselves to varying requirements. If the conditions for their installation and management are met, these lofty, bushy plants can simultaneously produce fodder, food and energy, provide shelter, break the force of the wind and possess all the advantages of self-protection. Their roots help to deepen and improve the soil; the shade they provide facilitates ecosys-

B. Ben Salem is the officer dealing with arid-zone forestry in the FAO Forestry Department.

tem metabolism; and they afford to plants less endowed by nature some of the benefits of the protection which they themselves enjoy.

With these functions in view and considering how best to combine the various elements necessary for the development of a stabilized agricultural system in arid zones, trees come immediately to mind as being essential for guaranteeing this stability and ensuring the continuity of agricultural activity. Such activity can be divided into three groups, based on the different ecological conditions prevailing in arid zones:

- Extensive stock raising, of a nomadic type, based on the use by wildlife and domestic animals of vast stretches of desert ranges.

- Grazing and forestry activities in arid areas, concentrated on natural grazing land.

- Agri-silvi-pastoral activity in semi-arid zones, combining arboriculture, crop growing, wood and animal production.

Farming in arid zones should be confined to areas where there are sufficient groundwater resources (springs, wells) or where it has been possible to concentrate surface waters by runoff. This also applies to trees, whether forest or fruit trees, because for trees the limiting factor is lack of water: either they produce a lot of wood and also consume a lot of water, or they consume little water but then also produce little wood. This either slows their growth or reduces them in number to a very few per hectare. Since the climax of arid zones is a shrub steppe, the possibilities for introducing trees of necessity are very limited. Rather than planting trees which grow upward, it would be better under these bioclimates to cover the soil widely with low vegetation to stop the sand being blown away, to avoid the formation of zones of accumulation through wind erosion, and to make the ground more rugged. A plant cover with the same characteristics as the original steppe should be reconstituted.

In semi-arid zones there are greater possibilities for crop growing and trees have an important role to play in stabilizing agriculture. For this they must either be permanently present or regenerate without interruption in the same area. In the first case, we would have permanent trees or shrubs either in rows or scattered about. Their role can be summarized as follows:

- Trees in rows protect crops against wind erosion and desiccation.

- Trees intermingled with crops protect the crops and reconstitute and enrich the soil.

- Thus improved, the cultivated zones lose their marginal character, rotation cropping becomes possible and a supply of fodder is ensured.

- The ideal combination of semi-forest trees bearing edible fruit, fodder trees and forest trees ensures not only a diversified and stable production, but also agricultural and biological balance.

In the second case, where trees are regenerated, they are grown during the fallow period as part of rotation cropping, in order to regenerate the soil and provide cattle with supplementary fodder.

How have desert peoples, whom outsiders might consider "primitive," come to terms with their environments? The answer is in the cohesive social systems of these groups which have enabled them to create and organize farming appropriate to their land and climate.

Management

The outline of an overall land-use management strategy thus begins to take shape. Shelterbelts of forest species would be reserved for the great plains, where division of the land into plots and the presence of active farming prevent the close juxtaposition of trees. The hillocky peneplains, hills and slopes would be protected by scattered vegetation and would, over most of their area, be converted into a network of plots to be cultivated under a system of rotation cropping based on the use of woody vegetation.

Land-use management plans and forest policies in arid and semi-arid countries to date have been designed for and implemented in well-defined, individual areas where the tendency of the forester was to protect and conserve the forest for its own sake rather than adapt it to the requirements of the rural people. This attitude may have been justified in the past but cannot be accepted today in view of the accelerated degradation of the soils, the marginalization of agriculture and the growth in population. The basic prerequisite for an improvement in rural life is stabilizing agriculture, and trees should not be confined to areas marked off as marginal. Forestry should be considered not as a residual form of land use but as an indispensable component in an overall land management plan. Its presence guarantees conservation of the environment, improved renewal of the natural resources and existence of the conditions necessary to enable rural people to live a satisfactory life.

This being agreed, the stabilization of agriculture then becomes the forester's main contribution, rather than trees, shrubs, erosion control or the production of fuelwood. The whole art of the forester, which is essentially an art of management, really consists of incorporating silviculture into management of the whole land area and encouraging the adaptations necessary to ensure a greater contribution to the stabilization of land use.

In most arid and semi-arid countries the problem of land management and the incorporation of trees is affected by the existence of traditional social and agrarian structures. The fragility of the environment and the variability and shortage of rainfall have led to judiciously adapted structures geared toward protection of the environment as providing the only guarantee of existence. Serere agriculture offers a good example of the degree of adaptation which has been attained in arid bioclimates. The Sereres are peasants living in western Senegal, a region with poor soil and low, variable rainfall. They have succeeded in maintaining the fertility of the soil by planting useful trees in the cultivated fields, making regular use of the bush fallow system and adding manure. They have managed to feed themselves under difficult conditions while maintaining a stable environment even with a dense population.

Other examples can also be cited, such as the Dogoan and Hausaland regions in northern Nigeria, where population has reached a high density without degrading the environment, thanks to the fallow system, crop growing under the shelter of trees, and the use of manure.

How have these peoples, to whom outsiders might — mistakenly — apply the term "primitive," been able to come to terms with their natural environments, even conserving these environments? The answer may be found in the cohesive social systems of these groups which have enabled them to create and organize appropriate ways of farming.

Whatever strategy is adopted for the management of arid areas, enduring social structures such as these should not be neglected. Enhancement of these structures would bring nothing but benefits. Simple judicial or legislative changes would suffice to ensure that these structural groups, which are in fact management and action units, be officially constituted and recognized as the key element in land management. In addition, simple improvements of traditional techniques, which can be understood as mastered by the population, are very important. These should be adapted to local ecological conditions and should require only a minimum of imported products or experts.

The role of technical assistance would be to provide continuing advice, information, training and follow-up in the field on all operations involved in the establishment, management and utilization of the plant infrastructure and soil improvement. The essential requirements are to understand the needs of the people and ensure their active participation in forestry activities. This presupposes a real dialogue with the rural communities in order to make them truly aware of the contributions of trees and forestry activities and of the necessity to integrate them into plans for the management of their land. This dialogue, this information, this training must be based on a thorough knowledge of social and economic structures and of the requirements of the rural communities.

The technical abilities required for this type of assistance are certainly much broader than those traditionally needed to manage a protected area, for instance. Henceforth, technical experts will have to find ways of incorporating trees into land-management plans and other forestry activities with the technical support which will enable them to face up to growing, and changing, requirements. This will require a multi-purpose orientation which will take into account the objectives of agricultural stabilization and wood production, the necessity to conserve the environment and the desirability of full integration into rural development.

It is essential that there be close cooperation among the various services to which the technical personnel are attached and the agencies working in planning, assistance and distribution of facilities. If necessary, increased responsibilities should be delegated within the forestry administration itself. This would lead to a progressive reorganization of the forest services and the recruitment of non-foresters (specialists in animal production, agriculture, veterinary science and sociology) who could collaborate with foresters and form a truly versatile forest service.

Planting trees to stabilize agriculture is more costly the more arid the climate and the more degraded the soil. What is really involved is reconquest of the soil based on the establishment of a ligneous infrastructure. Since this represents an enormous expenditure, it can be easily understood why there should be hesitation about undertaking it. It will, however, have to be undertaken sooner or later. It is not sufficient merely to mobilize the local workforce for multi-purpose plantation work after education and active propaganda; they must also be given all the help necessary to obtain for themselves the means necessary for this new activity. In other words, it is necessary to provide assistance based on an obligation on the part of the state and commensurate with real requirements. This assistance may, according to the circumstances, be limited to education, organization and demonstrations, or it may take the form of material assistance: donations, subsidies and loans of money or material.

Such assistance, based on the incorporation of trees by and for the people, will cost less than large-scale reforestation on state lands. In fact, for the same amount of money, the achievement, measured either by area restored or by number of trees planted, will be much greater than if the work is carried out by the administration alone. Finally, this assistance will do more for the rural economy than could be expected from wood production alone.

Arid zones present problems of land use and of stabilization of the bases of agricultural production. Forests, trees and shrubs, as well as annual plants, have an important role to play in this connection and represent perhaps the primary means of arriving at a balanced rural economy and perhaps even the only way of avoiding degradation of the land. As elements essential to the overall stability of agriculture in these zones, trees cannot be relegated to a secondary role but must form an indispensable component of rural management, and this must be managed with and for the people within the framework of a new administrative orientation and with adequate financial and technical assistance. ■

Japan's forest resources

Mitsuma Matsui

Forests cover two thirds of Japan's land area, and generally tree growth is favoured by the temperate climate, abundant rainfall, and fertile soils. For centuries forests have served the Japanese people in many ways. Foreign visitors will be surprised to discover how intensive and complicated forest land use is in Japan. Over the years, management has been in reasonably good accord wth natural and social conditions, but recently many problems have arisen — for example, conflicts among land uses and a decline in vigour of the forest industry.

Natural regeneration is occasionally employed for creating high forests — of *Pinus densiflora*, for example — but diversity of species and luxuriant undergrowth usually make it unfeasible. The most common method has been the planting of nursery-grown seedlings (or cuttings in some cases) after clearfelling.

In some localities tree planting for timber production dates back more than 300 years. Especially toward the

MITSUMA MATSUI is Director-General of Japan's Forestry and Forest Products Research Institute, Ushiku, Ibaraki. This article is a short version of one that appeared in the *Journal of Forestry*, Washington, D.C., February 1980.

JAPANESE VILLAGERS DONATE THEIR LABOUR TO REFORESTATION ON ARBOUR DAY
where forest consciousness is in the people and trees cover two thirds of the land

end of the nineteenth century, traditional techniques developed in these areas greatly stimulated intensive practices in other parts of Japan. It was after World War II, however, that planting was expanded from rather limited areas to a nation-wide scale and in all classes of ownerships. Today more than one third of the forest land in this country is planted. The popular species, in decreasing order of planted area, are sugi (*Cryptomeria japonica* D. Don), hinoki (*Chamaecyparis obtusa* Endl.), karamatsu (*Larix leptolepis* Gordon), akamatsu (*Pinus densiflora* Sieb. et Zucc.), todomatsu (*Abies sachalinensis* Fr. Schmidt), and akaezomatsu (*Picea glehnii* Mast.).

The latest forest resource statistics, current as of 31 March 1976, are summarized in the table. Forests cover about 25 million ha, or 67 percent of the total land area, but the amount per caput is only 0.2 ha, as compared to the world average of 1.2 ha. National forests account for 31 percent, and private forests for 59 percent. National forests are mostly in remote mountainous districts, and include a large number of protection forests and national parks.

Several years ago, the Forestry Agency set as a target 13 million ha of man-made forests on sites with the capacity to grow 5 m^3 or more of wood per ha annually in fully stocked plantations. I. Mashimo, soil scientist, identified (1973) forest area suitable for plantations as totalling 12.7 million ha. Some 10 million ha were found to be unsuitable for clear-cutting and planting because of poor sites, but they appeared to offer a potential for timber production under natural regeneration. The remaining area was non-productive forest and bamboo forest.

About 9 million ha, or 37 percent, of total existing forest are already in the man-made category. Its composition by stand-age class reflects the historical trend in annual planted areas. Young stands less than 25 years old cover 80 percent of the total man-made forest area. They are distributed among the five youngest age classes like a pyramid. Stands 10 to 15 years old occupy the greatest area, because of the rapid increase in planting soon after the war and the gradual decrease after a peak of 415 000 ha was reached in 1961. In recent years the planted area has been about half that level.

The total growing stock is 2.2 million m^3 or 87 m^3 per hectare. Man-made forests, mostly of softwood, have slightly less growing stock (85 m^3/ha) than natural stands (96 m^3/ha), which include the old growth. A breakdown of growing stock of man-made forests by species shows that sugi occupies a dominant position (59 percent) followed by hinoki (20 percent), akamatsu (9 percent), and karamatsu (8 percent).

Annual removals from growing stock in the 1953-67 period fluctuated narrowly between 70 and 75 million m^3. The share of industrial wood, though, increased remarkably from two thirds to nine tenths of all removals, making its gain at the expense of a constant drop in use of fuelwood. Thereafter, total timber removal trended downward, and in 1975 it dropped below 45 million m^3.

It seems clear that the recent level of removals is considerably lower than the annual growth of all forests: most of the plantations are too young to harvest. In fact, the growing stock increased by 107 million m^3 (man-made forests + 133, natural forests −26) from 1971 to 1976. As removals during these five years totalled 264 million m^3, simple calculation tells us that the average annual growth was 74 million m^3, exceeding the removals by 40 percent.

Such a favourable balance was achieved mainly through the rapid reduction of the harvest, which in turn produced a big imbalance between consumption and supply of home-grown timber. Consumption of round-wood volume rose to 118 million m^3 in 1973, a peak in a trend that had risen from around 65 million m^3 in the late fifties. Reflecting a slowdown of the economic growth of Japan, recent consumption has somewhat declined to about 100 million m^3. On the other hand, domestic timber production showed a trend similar to that of removals, dropping from 57 to 36 million m^3 between 1967 and 1976. To meet the ever-increasing deficit of wood products, import of logs and other processed wood increased sharply to 65 percent of total supplies in 1976. About half of the log imports consist of tropical hardwood, and most of the rest are softwood from the United States and the USSR.

In sum, the condition of timber land in Japan has improved in the recent decades primarily because of extensive conversion from poor hardwood stands to plantations of conifers. In the future, these plantations will expand the country's supply of softwood considerably, but at present they are mostly too young to offset the decline in supply from natural stands. Furthermore, recent unfavourable trends in domestic timber prices, together with a sharp rise in forestry wage rates, have undoubtedly influenced owners' willingness to sell timber. ■

Forest-land area and growing stock in Japan

Forest type	Area		Growing stock		
			Softwoods	Hardwoods	Total
	1 000 ha	*Percent*	..... *Million m^3*		
Man-made	9 377	37.1	788	10	798
Natural	14 437	57.2	426	959	1 386
Others	1 449	5.7	1	1	2
Total	25 263	100	1 215	970	2 186

Source: Forestry Agency (1978).

A case study

Agri-silviculture in Uganda

Muhammed Azfal Chaudhry and Salim Silim

Agri-silviculture is a production technique which combines the growing of agricultural crops with simultaneously raised and protected forest crops. This practice, called agri-forestry, has been in existence in various primitive forms since man learned to clear forests and cultivate land, and has different names in different parts of the world. In western and central Africa, the age-old habit of swidden agriculture, or "shifting cultivation," involving continued destruction of forest areas by cutting and burning and then raising the agricultural crops on the ashes of the destroyed forest, seems to be the beginning, however crude, of this practice. In Kenya they call it "shamba"; in parts of Europe and a large part of Latin America it is called "squatter planting". A similar practice involving forest villagers and tribesmen is known as the "taungya system" in Asia. The origin of the taungya system can be traced back to 1862, when the colonial British employed Burma's taungya tribes for raising teak plantations along with their paddy (rice). In Indonesia, Malaysia and other tropical countries of southeast Asia, the practice is remarkably similar to that of shifting cultivation in Western Africa. In the local vernacular of Bangladesh the practice has been most appropriately called "jhooming," which means going round and round and never standing at one place; the farmers would change the site every year moving, year after year, throughout the available area. Various forms of shifting cultivation are still destroying forests, degrading land and causing erosion in many parts of the world on a vast scale. There are an estimated 3.6 thousand million hectares currently under shifting cultivation throughout the world, and it is believed that some 250 million persons live by it.

The present-day concept of agri-silviculture is in fact a way of reconciling conflicting interests of native cultivators and foresters and also is seen as a valuable and workable means of diverting the pernicious systems of shifting cultivation into constructive channels. This involves the establishment of an agricultural-cum-silvicultural cycle so as to use the labour of shifting cultivation to establish and maintain trees. It has come to be a valuable symbiosis and it is being accepted as a very popular system, wherever conditions are suitable, for promoting the economic and social development of the people living within or near the forest area, and simultaneously preventing the degradation of soil and vegetation.

The technique holds a significant position in tropical silviculture. As a form of land use, it aims at an integrated use of the available land resource to obtain a maximum amount of goods and services (Davis, 1968). In various ways agri-silviculture seeks to create harmony between crop farming and tree farming. Decidedly, the system is not an easy one and at times the plans may not fully materialize. Indeed, those patient, flexible and intelligent administrators who understand and sympathize with the forest farmers, their traditions and their human needs are among the most important elements of success of any system of agri-silviculture.

In Uganda, the system does not have a long history. It started as a form of tree farming when the hardwood species *Maesopsis eminii* (Musisi) was raised in combination with cocoa to provide partial shade to cocoa in its initial years of growth and to produce Musisi timber into the bargain. Later, a small-scale taungya system was applied in the Kifu forest to regenerate some indigenous trees. Taungya plantations were also developed for planting exotic pines in the Mwenge plantation, near Fort Portal, and at a few other sites with varying degrees of success and the system is being currently applied in the Sebei and Lira Districts where large-scale plantations of pine and cypress have been taken up under agri-silviculture. One such site is the Kachung Forest, the focal point of this study.

The Kachung Forest Reserve with an area of 35.4 km^2 is located 27 kilometres south of Lira town along the Lira-Soroti road in Uganda. The area has two peak rainfall periods and three to five months of dry season

Muhammed Azfal Chaudhry and Salim Silim are with the Faculty of Agriculture and Forestry of Makerere University, Uganda.

every year. The wet spells last from April to May, and from August to September. The relative humidity at midday is estimated to be 30-65% during the dry season and 60-95% during the wet season. The temperatures are quite high, maximum 29.5-35°C during the dry season and 21-29.5°C during the wet season. The minimum temperature never falls below 15.5°C. The soil is mostly lateritic with reddish brown sandy clay loam at few places overlaying the laterite. Before its establishment as reserve this vast savanna area was being used as a communal grazing land. Subsequently in 1938, abortive efforts to plant *Chlorophora excelsa, Khaya grandifolia* and *Gmelina arborea* continued until 1950. The emphasis then shifted to trials of softwood plantation which showed their results around 1970. Soon after, fairly large-scale plantation work started with *Pinus caribaea*, and on a limited scale with *Pinus patula* and *Pinus oocarpa*.

There is no definite record indicating exactly when the agri-silviculture (taungya) practice was started in this plantation. According to verbal reports it is generally believed that it started around 1966/67 when the villagers living within the forest area, urged by some teachers from a neighbouring primary school, were encouraged to take up some land for cultivation by the Forest Department. They quite willingly took up the land, though on a quite small scale. That state of affairs continued up to the end of the sixties when the Forest Department decided to expand the operation by developing a new strategy. The local village chiefs were approached to convince the local people around to extend cooperation to the Forest Department by taking up plots for taungya practice. At first the call met with a mild response from the local people, with just a handful of farmers joining the older lot. However, by 1970/71 there was a great inpour of people who took up plots. This was mainly due to the realization by the farmers that the area was agriculturally very productive. Since then the interest of the people has grown year after year.

Generally, the people use the land around the forest in two basic ways:

- Raising crops, mostly for food, such as millet (*Eleusine coracana*), pigeon peas (*Cajanus cajan*), cotton (*Gossypium* sp.), sorghum (*Sorghum vulgare*), simsim (*Sesamum indicum*), groundnuts (*Arachis hypogaea*), several types of beans, cassava, sweet potatoes, various local vegetables and some sweet bananas.

- Keeping cattle, and some other domestic animals like goats, sheep and poultry. The cattle graze usually in communal grounds set aside for the purpose, away from agricultural areas. Because there is no risk of their trespassing into anybody else's cultivated garden, the cattle herds are let free every morning to graze on their own and are collected in the evening. The sheep and goats are not usually herded but are tied near the homestead except during the dry season when they are also left free. The use of grazing land is unplanned.

People work the land with a hoe — called locally the "lango hoe" because most of the inhabitants of the area belong to the Lango tribe. It consists of a flat heart-shaped blade fitted onto a rather long handle. Such hoes are exclusively used in the Lango area. Very few farmers possess ox-drawn ploughs.

There exists a customary land tenure system in the area, both for cultivation and grazing. The land usually belongs to a tribe, clan or family. In some cases it belongs to various individuals in the family, later inherited by their offspring, and this often leads to possible fragmentation.

Any land which has been lying unoccupied for ten years can be occupied by an individual, a family or a clan. The occupation must last for a long time and the land put into effective use during that period without anybody else claiming it, before ownership can be proclaimed. Despite the system of customary tenure, the lands under Uganda laws are known as public lands, vested in the land commission of the Government of Uganda, and are administered by the District Land Committees. Because of a rather light population pressure there seems to be no serious land problem in the area at present. However, there is a great hunger for fertile lands, which are shrinking.

The method of cultivation consists of clearance through repeated burning of all the existing vegetation, next digging, then sowing or planting, digging for weeding, harvesting and clearing the remains again by setting fire.

The Langos have a communal system of land cultivation known as "Wang tic" in their language. The system carries many local nicknames in various parts of the Lango district. For example, around the forest reserve it is referred as "Alulu". This is quite an old form of cultivation. All persons, male or female of all age groups capable of carrying out cultivation work, belonging to a homestead or a group of homesteads, organize themselves into a "Wang tic". The leader of the group is chosen by the members. He is responsible for the organization of the cultivation, and fixes the order of cultivating the "gardens". The area covered depends upon the size of the "Wang tic". During the digging, each person is allocated an area to complete and the straggling members are usually helped. After every such cultivation the owner of the garden has to provide local beer ("Kongo ceke" or "lacoi") or occasionally a meal.

After the demarcation of annual planting coups, the initial clearing of land is carried out by the Forest Department toward the end of the dry season. This involves cutting down the entire existing savanna vegetation, except for a few valuable tree species. The cut trees are either sold as firewood or converted into charcoal and then sold. Usually fires are avoided as a precaution against any possibility of a serious outbreak of forest fire.

The planting operation is completed by the Forest Department before the farmers are allowed in. The forest species are planted at 3 × 3 metres spacing soon after a reliable rainfall, that is, when the wet season has really begun. The land allocation to farmers is usually done on a first come, first served basis. The maximum area allowed per tenant, usually a family,

depends on the capability of the tenant which is judged by the size of the family and his social status. The bigger the family and the better its social status, the greater is considered to be the capacity of the tenant. While the allocation of plots is proceeding, tenants who wish to be neighbours can choose to have adjacent plots.

The tenants are not allowed to burn anything at any time in their plots. They can grow any annual crops but no perennials are allowed which are liable to cause suppression of the tree seedlings. The number of years for which a tenant can keep a plot are not stated at the outset. The maximum allowable period is dependent on the degree of crown closure of the forestry crop, the type of agri-crop to be raised and the degree of soil fertility. Ordinarily three to four years are required before the farmer can change the site. During the occupancy the farmer is required to look after the forest plantation.

The demand for land has been gradually but continually increasing. Most of the area taken up is along the Lira-Soroti road. A survey of tenants ac-

A FISH POND COMBINED WITH FORESTRY ACTIVITY

where communal farming traditions favour the growth of taungya

cording to sex and age shows that a greater part — 60 percent — of the tenants come from outside the forest area and are middle-aged women. The workers from within the forest area are, however, mostly young males.

To assess the effects of inter-cropping on the main tree crop, which is *Pinus caribaea* in Kachung, measurements and observations were taken in areas having almost the same age but have been under agri-silviculture for varying lengths of time. Because of the size of the available plots, 100 percent of the full area of each type was included in the study.

The agri-forestry practice has a beneficial effect on the condition of the forestry crop mainly through the elimination of the rank growth of weeds, which offer a very strong root and shoot competition to a sapling raised in an area where there is no agri-forestry or it has been practised for only one year. Weeds in such cases are ineffectively removed and readily reappear. The most abundant weeds of the area are: *Imperata cylindrica* (sword grass); *Acacia hockii*; *Hyperrhenia rufa*; *Acacia mellifera*; *Grewia trichocarpa*; *Vangueria opiculata*; *Asparagus flagellaris*; *Combretum* spp.

Imperata cylindrica is a suppressant which tends to grow in pure forms excluding almost all other vegetation. It is very difficult to control during the first year of cultivation because of its sturdy rhizomes.

As for the effects of agri-silviculture on agricultural crops, information obtained from the farmers working in agri-forestry has been compared with answers from farmers working on other lands in adjoining areas.

All the agricultural crops tried so far under the system have proved promising and their yield is better than the outside land. The cultivation of agri-crops has to stop when the tree canopy above closes. There is a declining trend in production on both types of land due to the effect of soil leaching and exhaustion of fertility.

Taungya's effect on the local ecosystem

Because the farmers clear the site of weeds through hard work, they would like the area to be available for cultivation for a longer period. This at times provokes feelings of hostility in the farmers toward the tree crop. Some of them would even physically uproot the tree while digging the adjoining land. Some instances of heaping weeds on top of saplings have been recorded. In other cases fires were initiated to kill weeds which had reappeared after the first year. But all such instances are exceptions rather than the rule and such tendencies are very much controllable.

There has so far been no serious attack of pests or diseases on either the trees or the agricultural crops growing together. In April 1977 there was however a grasshopper attack on millet. That appeared to be a region-wide attack, which was not restricted to the forest area, although some of the farmers alleged that the attack was more severe in the forest area. There is also no evidence of attack by monkeys and browsers present in the forest reserve on the agricultural crops.

Though soil working had improved the aeration and water-holding capacity of the soil a small incidence of erosion was observed on slopes, especially on sites where the agricultural crop was still young. Nevertheless, local farmers and forest workers are of the view that replacing of the rank growth of weeds with agri-forestry crops had greatly improved the aesthetics of the area. The enhanced production of agri-crops and improved rate of growth of trees are an important socio-economic contribution to the area.

Generally, the people involved in the practice (the farmers and the Forest Department) are satisfied with the yield of crops from the land, the present land allocation system and the present way of working. The practice has evolved a sort of block farming. The Forest Department employees continually check their tree-crop though some of the farmers discourage them from passing over the cultivations. Because of the general economic condition of the farmers, mechanized farming seems to be a remote possibility unless some other agency takes the initiative.

Effect on labour costs

If agri-forestry had not been adopted, the Forest Department would be employing labour to carry out the entire tree-planting operations. For example, the planting coup of 1977 only, as calculated from past records, would have required 8 120 additional mandays to establish the plantation of *Pinus caribaea* over 116.5 ha over the first three years.

And in spite of so much investment the achievement would be only forest trees, which anyway are favourably affected under agri-silviculture.

Agri-silviculture — or taungya — is a method seeking in various ways to create harmony between crop farming and tree farming. It is a compromise between two apparently conflicting demands. It is not easy and may not always work as planned. But in the tropics, where the pressure of population is ever-increasing, such compromises are the only answer. Shifting cultivation and savanna land utilization have to be integrated to get timber, food, fuel and other allied products to ameliorate the economic condition of the developing tropical countries. It is believed that in the world today an estimated 3.6 thousand million hectares are under shifting cultivation and some 250 million people live by it. In Uganda alone about 10 percent of the total land area (its savanna) is ravaged by the fires caused by shifting cultivators or graziers each year. This calls for a change: change in land utilization, change in attitudes and change in the ultimate fate of millions of people. And agri-silviculture brings in a series of changes.

Ecological factors

No doubt there is quite some amount of change caused by the planting of trees alone, without involving the taungya system (Johnson, 1976). And the change is much greater if the tree rows are interplanted by agricultural crops. The rate and extent of change

appear to depend upon the number of years of cultivation and the type of crop cultivated. In the Kachung area, after one year of cultivation there is a sudden vigorous re-growth of grasses, herbs and shrubs. *Imperata cylindrica* tends to come back in a big way, and after it has been weeded out again there is a quick invasion by lesser competitive species. That is why the areas that are cultivated only once may not ultimately be very different from those that are not cultivated at all. The vegetation changes become more and more conspicuous and permanent as the number of cultivations increase. The constant and repeated cultivation has the effect of making the vegetation simpler, as the farmer makes incessant efforts to keep his crops weed free. And as the pines grow and close up, a new type of vegetational cover develops which is quite different from that in the neighbouring unplanted areas. The trees influence the environment through casting shade, keeping the temperature low, minimizing evaporation from the soil surface and affecting the microflora and microfauna of the soil. A new microenvironmental set-up comes into being. *Imperata cylindrica* cannot re-invade the area under pine shade as the grass is not shade tolerant.

As can be seen from the foregoing, the taungya practice has its beneficial effects on the growth of pines. The faster rate of growth is due to reduction in competition from grasses and other weeds. Most agricultural crops tend to be less competitive than the natural vegetation. Tropical soils are extremely susceptible to nutrient leaching, particularly when the ground is made bare of its vegetational cover by exposure either through cultivation or through other means. The soluble substances are continually washed down into deeper layers of soil. Some of these nutrients are drained down while the rest are taken back by the deep-rooted plant communities. Since it is only the pines that are a deep-rooted vegetation within the agri-silviculture area, they take back those nutrients. This in part may also account for the increased vigour in growth of the pines.

The agricultural crops, in their own way and at a given depth, also compete for nutrients with young pine seedlings. Millet, when looked after properly on a fertile soil and allowed to establish, forms a thick network of adventitious roots and a dense growth of parts above ground. It is therefore essential that the pines be given an initial advantage over millet, perhaps by delaying the sowing of millet or not sowing millet in the first year. Pines can comfortably cope with millet in the second year and onward. *Cajanus cajan* (pigeon peas) also need the same precautions. They grow to form a sort of shrub attaining a height of over 1.5 metres within three to four months and tend to overtop the pines in addition to making nutrient demands on the soil. However, an obvious result of the taungya practice is an increased yield per unit area of the agricultural crops during the first year. This is due to the still unleached fertility of the soil — the state of being uncultivated is a form of fallow and it is known that fallow is the best way to maintain tropical soils in the absence of fertilizers. The longer the fallow period, the better. The effect of allowing land to remain fallow results in striking increases in yield, regardless of fertilizer treatment. During the second year the yield of agricultural crop falls and from the third year onward it almost becomes constant. Obviously this decline in yield is due to a decline in the availability of nutrients. The yield can be raised if somehow the tillage can be taken deeper than the layer which is used during the first year. The cultivation can continue to about four years when the pines almost close up the canopy.

Effects on socio-economic aspects

Although communal farming has been in existence in the Lango area of Uganda for a long time, the system has got better organized thanks to the taungya practice. In traditional communal farming the shambas (gardens) are scattered, but the taungya system has brought them closer. Equity in site, working conditions and walking distance have gone a long way to remove unnecessary grudges and have helped the people to get better organized. This is reflected by the fact that at occasional parties — like at Christmas, Easter and other occurrences — usually organized within the forest reserve by workers, outsiders are welcome. Conversely the people living next to the forest invite the forest and taungya workers to their parties as a group. Block farming has decidedly contributed to the social development of the community.

Millet and pigeon peas are the main staple foods of Uganda's north and they can be grown as agri-silvicultural crops.

The taungya system has a tangible effect on saving the operational cost of afforestation. Another benefit is the faster rate of growth of the trees resulting in more yield in shorter rotations. Not only the Forest Department gains directly, but it is the farmer who gains more from an increased yield of his agricultural crops. And this benefits is available on a sustained basis as every year new areas keep coming under agri-silviculture. That is why there has been a constant increase, every year, in the number of people engaged in the practice.

It should, however, be noted that the practice of agri-silviculture in Uganda has passed its infancy but is still young. Through careful planning and wise manipulation vast lands and human resources can be put in a progressive and productive combination. The communal farming habit of the people can be used very advantageously by educating them in agri-silviculture. Terms and facilities can be improved and the timing of planting the forestry and agricultural crops can be suitably adjusted. Research is required on suitable crop rotations and possibilities of introduction of perennial crops like cassava and dessert bananas. There are opportunities for helping the farmers by making tractor-hire services available, by arranging convenient sales of agricultural crops and by procuring basic agricultural tools and insecticides, at reasonable costs. Agri-silviculture needs to be carried out as a matter of policy and not only as a localized means to get free labour for forest areas. ■

Dynamics of marketing tropical timber: three studies

Concepts and guidelines for the utilization and marketing of tropical timber in a changing supply-and-demand situation

Recent trends in tropical timber production and trade show that increasing quantities of roundwood are processed in tropical countries for export and domestic consumption. More attention needs to be given to the use of hitherto unconventional tropical wood raw materials.

Here are summaries of three studies that were prepared at institutes in different regions of the world at the request of FAO. These summaries were first presented to the Fifth Session of the FAO Committee on Forest Development in the Tropics held in Rome in May 1980.

Summary 1

Evaluating concepts for the improved utilization of tropical timber resources

M. Chudnoff and R.L. Youngs

Both temperate and tropical forests have rich arboreal flora, but in the temperate zones only a few species make up the bulk of the growing stock as well as the harvest. Thus, high volumes of salable timber can be removed from comparatively small land areas. In much of the tropics, the harvest has also concentrated on a few species, but with only small volumes suitable for local and foreign markets. Often, 90 percent of the forest volume has a mix of hundreds of species that are considered as non-usable. To further complicate this poor resource utilization, no silvicultural systems that are economically attractive are available to sustain supplies of most current species of choice.

The tradition

Since the beginning of this century, evaluations have been made of the physical, mechanical, chemical and anatomical properties of thousands of timbers, species by species. Most are tropical. There appears to be little relationship between the technical information available and the marketing potential of a species or species group. Whether or not testing procedures are standardized may be irrelevant.

Characteristics of the high-demand marketable species harvested in tropical America, West Africa and Southeast Asia show a remarkable variety of properties. They range from attractive to plain, from high to low strength, from highly durable to perishable, from good to poor quality for machine treatment, from easy to dry to difficult to dry. The only features common to all preferred species are large log sizes and more frequent occurrence in the forest. For example, of the 4 000 tree species found in the Philippines, only 316 are classified as large trees and only 60 are obtainable in quantity. From the marketing point of view, tree size and abundance are more critical than the technological properties of the wood.

End use

Because most lesser used species are few and widely scattered, attempts are being made to increase volume concentrations by pooling species with similar properties for a particular end-use. In Australia, systems have been developed to group many species into a few structural classifications. Research is being done there and in England to define desirable processing and end-use properties for such purposes as joinery, flooring and boat building. Principal component analysis is being used in France and Japan to better define the end-use potential of a species or groups of species. But will this end-use direction solve the problem? Some three decades ago about 30 species from a country in South America, all available in some quantity, were thoroughly tested. Characteristics suitable for a wide array of end uses were documented and opportunities to combine several species were available. Yet, only five of these species are currently selected for the bulk of the harvest.

Timber, as well as other natural resources, is commonly used in order of declining economic quality. This is true for domestic consumption as for exports to foreign markets. It has been established by experience that high current rates of timber consumption do not necessarily force future periods to do without, but rather to incur continuing higher costs because resources of successively lower quality are brought into use. These forces stimulate us to find techniques to defer cost increases by:

- Trying to substitute inputs (African mahogany for Honduras mahogany; light red meranti for okoumé).
- Trying to economize on the input (converting veneer peeler cores to lumber and converting residues into panel products; substituting decorative veneers of rosewood for solid wood products).
- Trying entirely different techniques of production (evolution of the pulp and paper industry from a few species suitable to a single pulping method to the qualification of all species using several pulping systems).

Technological developments that make the resource base more homogeneous, as for the pulping example, minimize or erase the restriction once

Robert L. Youngs is Director of the Forest Products Laboratory of the US Forest Service in Madison, Wisconsin. Martin Chudnoff deals with engineering properties of wood at the same laboratory.

thought inescapable in forest heterogeneity. But such technological developments often require large capital inputs. For local markets, perhaps concern has been focused too much on this problem of lesser used species. As first-choice species become scarce, other species will become attractive for that market. The lesser used species will remain so until their turn comes for market acceptance.

Utilization concepts

Examples of species-oriented and species-tolerant systems illustrate current concern with problems related to the improved utilization of the tropical forest resource. Species-oriented systems are concerned mostly with groupings of timbers for structural applications, but also with a "species-for-the-job" concept that describes properties important for manufacture and performance for a specific end-use and then lists qualifying candidates. The species-tolerant systems are illustrated by the obvious fuelwood-charcoal uses; incising to enhance absorption of wood preservative; strength grouping of structural components based on density or machine stress grading, and processing systems that make any mix of species economically viable to produce a wide array of paper and panel products.

Technological development can help interrupt the present step-by-step species selectivity process and this can be done by focusing on problems such as: developing rapid wood-drying systems that can handle species in mixes of any combination; developing wood-preservation systems that can protect impermeable but perishable species, using substances that are not noxious to people; developing paper-making systems that can be independent of coniferous furnish; developing new fastening systems for dense structural timbers, and much more. But even without such development, the potential exists today to make large volumes of forest resources marketable. This potential could be a tool for devastating forests if it is not used with restraint and care. But, it also offers forest managers an array of options to sustain a productive forest environment.

Any-tree/whole-tree concept

Concepts of marketing by species, marketing for end use, species groupings, and any-tree/whole-tree use can all play significant roles in the improved utilization of the tropical timber resource. But the any-tree/whole-tree concept has the greatest potential for resolving the problem of marketability of "lesser used species" in this decade.

Summary 2

Guidelines for the improved utilization and marketing of tropical wood species of the Philippines

Note that in this summary of the guidelines the term "grouping of species" is not related to the commercial grouping of species in international trade. The study summarized here is concerned with the evaluation of properties respective to processing and uses, and not with the establishment of commercial values.

Phase I

The evaluation of information and practical experience so far gained in the promotion and actual application of tropical wood species by grouping based on properties of solid wood.

A. Background information on the tropical hardwood situation in the Philippines and Southeast Asia is presented.

FROM A STUDY produced by the Forest Products Research and Development Commission of the Philippines.

In the Philippines it is estimated that there are still 1.5 thousand million m^3 of standing timber in the productive forests. The annual allowable cut is about 9 062 239 m^3.

Partial reports for 1979 showed that during the first quarter about 275 278 m^3 of logs, 116 897 m^3 of sawntimber, 8 048 m^3 of veneer sheets and 100 844 m^3 of plywood went to the export market.

Estimate of log export from the Southeast Asian Lumber Producers' Association (SEALPA) is about 33.8 million m^3 in 1979.

B. The wood properties and characteristics, based on solid wood in grouping species, are given and described. These are: (1) colour, (2) grain, (3) texture, (4) figure, (5) odour and taste, (6) wood deposits, (7) fibre dimension, (8) specific gravity, (9) shrinkage, (10) natural durability, (11) treatability, (12) seasoning, (13) strength, (14) sawing, (15) machining, (16) rotary veneering, (17) bending, and (18) kraft-pulping reactivity.

C. Lists of species under each grouping are presented with information on promotion as well as application of species for certain end uses by industry.

As the end uses of timber have created specific industries, the traditionally used species, recently used species, and those which may be used are included in each list. Not all Philippine timber species are included in these groupings.

A total of 334 species are included in the study.

Phase II

The establishment of property/use criteria including proposals for uniform methods to group wood species in relation to use properties.

A. End-use/property classification:

A classification of major end use for round timber and sawntimber and an enumeration of property requirements for each end use are presented.

For round timber, the following end uses are listed and their property requirements enumerated:

1. Poles, piles and posts — form, grain, specific gravity, strength, durability and treatability.
2. Pulpwood: chemical reactivity for chemical pulps, colour, specific gravity, chemical composition and fibre dimension.
3. Veneer logs (a) for plywood: form, peeling characteristics, drying and gluing; (b) for matchwood, chopsticks, toothpicks, etc.: form, peeling characteristics, colour, grain, odour and taste, seasoning, specific gravity and strength.

For sawntimber, the following major end uses are listed and their property requirements enumerated:

1. Heavy construction: bridges, sleepers, mine timber, truck bodies, etc.; specific gravity, strength, durability, treatability, spike holding and rail cutting (in case of sleepers).
2. Light construction: house framing, siding; specific gravity, strength, workability, seasoning, shrinkage, durability and treatability.
3. Furniture and cabinets: colour, grain, figure, specific gravity, strength, workability, seasoning, shrinkage and finishing.
4. Millworks and mouldings: specific gravity, strength, workability, seasoning, shrinkage, grain and finishing.
5. Joinery: seasoning, workability, texture and finishing.
6. Tool handles and sporting goods: specific gravity, toughness, workability, finishing, grain and texture.
7. Boxes, crates and pallets: specific gravity, strength, workability, odour (for certain boxes), fastening property and printability.
8. Musical instruments: resonance, workability, grain, seasoning and shrinkage.
9. Woodcraft, novelties and toys: workability, seasoning, finishing, specific gravity, odour and texture.

All the end-use properties are classified, for example, workability: (A) - good, (B) - fair, (C) - poor. The parameters for the classification are defined.

B. Proposals for uniform methods of grouping wood species in relation to use properties. For each end use, species are listed as to how they meet the property criteria classification.

C. Utilization statistics of species for different end uses.

An attempt is made to present available current statistics on the amount of timber utilized for every end use for domestic consumption and for export.

(It can be difficult to get statistics on volume per species utilized for every end use but whenever such information could be obtained from industry, it was included. Instances of market interest in buying non-traditionally used species are also cited.)

Phase III

Analysis of the implication of species grouping on timber grading and proposal for a suitable framework for grading rules designed to cover groups of species.

A. Implications of species grouping on timber grading in relation to local conditions and international markets are analysed.

Background information for analysis: The Philippines has a set of grading rules for peeler logs, veneer logs and sawlogs. These rules are applied for domestic and export logs. There also exists a set of standards for telecommunication and power transmission poles. These standards are applied by the National Electrification Administration (NEA) and by preservative treatment plants supplying poles to power companies. For railway sleepers, the Philippines National Railways has its own standards.

There is no uniform grading rule for locally sold sawntimber. For sawntimber exported to the United States, the US National Hardwood Lumber Association grading rules are applied.

B. Proposal for a suitable framework for grading rules designed to cover groups of species.

The framework is based on end-use property criteria and the species are listed or grouped into end-use classes. The end-use class refers to how well the end-use property criteria are met by the species.

Example: End use for furniture.

Species are considered in terms of how they need criteria formulated for three classes of furniture, designated classes (A), (B) and (C).

Existing grading rules for hardwood timber are considered insofar as defects are concerned.

A guide to overcoming problems of market access to Europe

J.T. Wassink and S.I. Wisselius

This is a practical guide, especially for producers, although consumers may also find it worthwhile reading. The booklet compiles the knowledge of the mechanism of marketing of tropical timber and is the result of 15 years of active study in this field. After defining what the word "marketing" really stands for, it starts to emphasize the interrelationship between marketing and management at the producers' end. It is, on the one hand, impossible to sell what the producer cannot make, while, on the other hand, management is obliged to produce timber in type and form, quality and quantity which can really be marketed. Therefore, market research is a must.

To be able to carry out market research on an efficient basis, it is necessary to have a good insight into the whole process of handling of timber from forest to end user. This sequence of operations is then linked to the unit costs for each one of them in percentages of the price at the factory gate in Europe. This picture clearly shows the importance of each step to the ultimate price of the merchandise. Again, the relation with management is pointed out. In principle, the man felling the tree should know what the ultimate product made from that tree is going to be. If *he* does not, management and the marketing office should know.

Market research means in the first place scouting for information; the booklet gives hints about where to find data answering these questions: *who* wants *what*; why does he want it; *when* does he want it; *what price* can he afford; *how* does he want his merchandise presented; *where* should it come from, and of course, *how much* is wanted. After discussing the functions and responsibilities of the different participants in the trade (producers, exporters, agents, importers, etc.) it deals with the sales contract and what can go wrong with it. A good contract is by no means a guarantee against trouble between seller and buyer.

The study of the local timber market in the tropics is a much neglected activity. Therefore, some aspects of this market are presented. A better exploitation of the local market may have a very strong influence on the profitability of the producers' enterprise. Some mechanisms which influence the tropical timber market, such as who decides on the choice of material for building purposes, what is the influence of growing prosperity on timber consumption and the attitude of the ultimate consumer, are discussed, as well as the attitude of trade and industry toward the introduction of new species.

Much attention is paid to the role of trade fairs in the complex of marketing activities: why go to a fair, or why not, and how to act at a fair are points which are highlighted. (Also see *Unasylva*, Vol. 29, No. 115, "Come to the fair," by J.T. Wassink.)

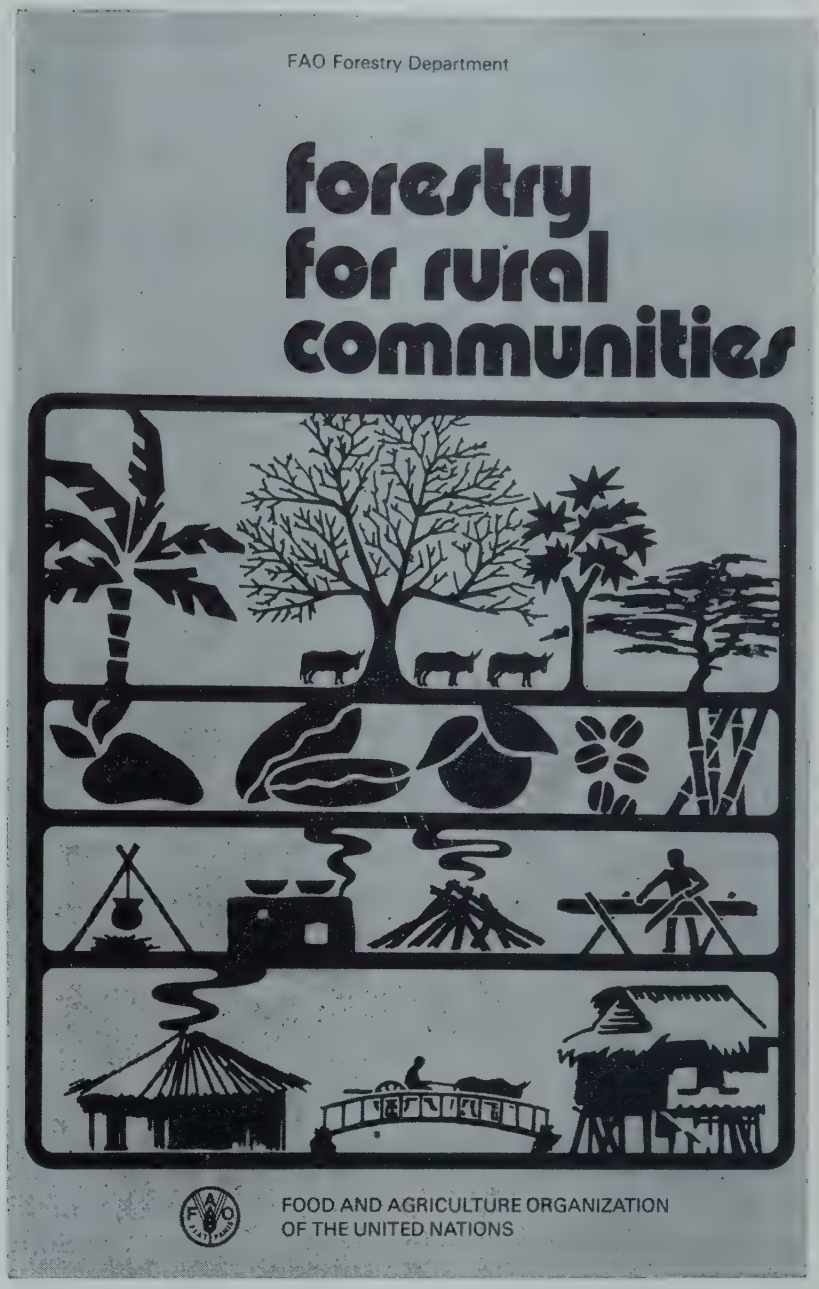
Exporting semi-finished and finished products is currently coming much to the fore in timber-producing countries. The booklet pays some attention to this much desired activity, but warns against too much optimism, for there are strong socio-economic counterforces within the potential consumer countries. The text ends with a paragraph on the possibilities of national/international cooperation between timber producers in geographically restricted areas. Psychologically, cooperation between parties that are fundamentally competitive is very difficult but, particularly in this field, much can be gained by trying.

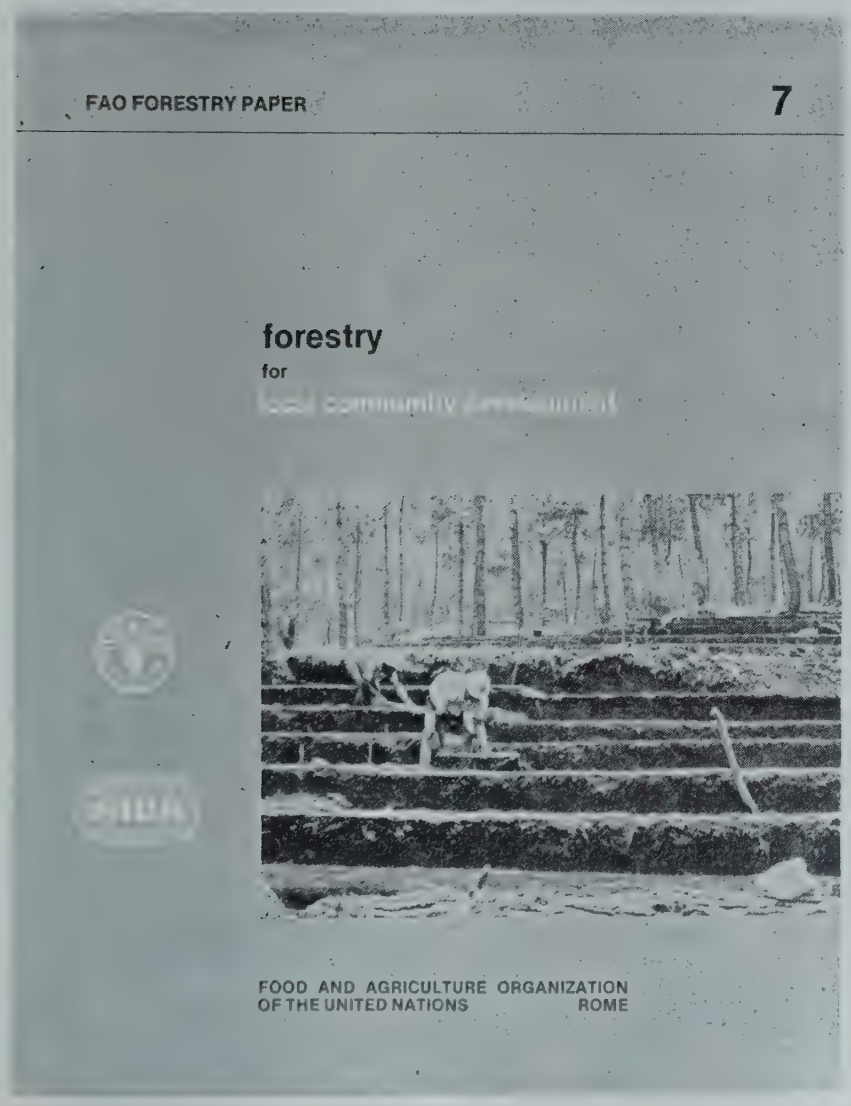
Of the appendixes, the one containing the addresses of the most important organizations could be very useful. They are presented in three categories: United Nations and related bodies; international and regional organizations; addresses per country (Western Europe and USA) which include addresses of governmental institutions, trade organizations, institutes and trade journals.

The other appendix lists some subjects that may occur in publications on marketing of timber. ■

J.T. Wassink and S.I. Wisselius are with the Royal Tropical Institute of the Netherlands, Amsterdam.

Forestry for people





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Biomass research: a survey of recent US government efforts

Jim Williams

The research and extension efforts of the US Department of Agriculture are directed toward increasing the availability of woody and agricultural biomass materials, materials which are used not only to produce alcohol fuels, but also for direct combustion and production of other forms of energy. The US alcohol fuels programme is therefore not a separate entity, but an important component of the total biomass and synthetic fuels production effort.

Huge quantities of agricultural and forestry residues and wastes are generated each year in the United States along with the production of agricultural and forest products. Some 500 million dry tons of wood are potentially available, but remain unused, each year. Plant wastes such as cereal straw, corn cobs and stalks, and sugarcane bagasse total about 400 million tons of organic solids yearly. Farm animals, many of which are raised in confinement, produce another 210 million dry tons of organic matter yearly.

Total agricultural biomass from residues and wastes constitutes well over one thousand million tons of dry matter produced annually. Since the net energy yield from a ton of dry organic matter is roughly equal to 1.3 barrels of oil, the fuel equivalent, in Btu value, of this resource would be 1.3 thousand million barrels of oil annually.

Research and development

The USDA is expanding its research and development efforts in support of the production of alcohol fuels from agricultural feedstocks. This research on alcohol fuels is conducted mostly by the Science and Education Administration (SEA), Forest Service (FS), and the Economics, Statistics, and Cooperatives Service (ESCS) of the Department.

Much of the research on biomass and alcohol fuels is conducted through SEA Energy Research Centers located in Peoria, Illinois, and Tifton, Georgia, and the Forest Products Laboratory in Madison, Wisconsin. The staff at the Peoria centre is involved in screening thousands of crops for starch and sugar content, examining other biomass materials to be utilized in large-scale conversion, and evaluating of large-scale conversion processes. Staff at the centre at Tifton are evaluating the production, harvesting, and conversion of wood and crop biomass to alcohol and other energy forms, and are using small-scale biomass energy systems on the farm. At the laboratory at Madison they are examining the conversion technologies for use of wood as a source of energy and petrochemical substitutes.

Ethanol

Because the technology is well estab-

Jim Williams is Deputy Secretary of Agriculture, United States Department of Agriculture. This report is condensed from one he gave in March 1980 to the US Senate Subcommittee on Agricultural Research and General Legislation.

lished, ethyl alcohol has been the sole material used in the blending of gasohol sold in the United States. The blend of 90 percent unleaded gasoline to 10 percent anhydrous ethanol can be utilized without engine modification and with no apparent damage.

Since petroleum prices have been low during previous decades, comprehensive research effort on the utilization of ethanol as a liquid motor fuel has not occurred since World War II, when petroleum stocks were threatened. With prices now rising and supplies diminishing, additional research is clearly needed in the near future.

One important research area is the screening of large numbers of plants which show promise for total biomass production, high yields of hydrocarbons, and the development of substitutes for petroleum products. Research efforts will also include enhancing biomass plant production through selective genetics and plant breeding.

The ESCS is evaluating the economic impacts of different types and levels of biomass production on the structure of agriculture and the effect on rural areas. Potential areas where structural change would occur include size of farm and ownership patterns, regional shifts in areas of crop and livestock production, different combinations of enterprises, and employment shifts in agriculture and rural areas. The effect on food price increases will also be estimated.

Research is also under way at the Peoria centre and at cooperating institutions to enhance the fermentation and chemical conversion process. This involves selection and evaluation of microorganisms for the ability to produce alcohol at a higher concentration, greater rate, or to function under a variety of fermentation conditions and substrate types and concentrations.

During World War II, the Forest Service developed an improved process for making ethanol from wood. A pilot plant was built in Springfield, Oregon, and while it never became operational, there is renewed interest in the technology. This technology is currently being used in about 40 plants in the USSR.

Forest products are being utilized by a wood pulping mill located in Bellingham, Washington, to produce about 4 million gallons of ethanol annually. This plant utilized waste sulphite pulp liquor as the feedstock material.

Methanol

Wood alcohol (methanol) can also be used to displace petroleum-based fuels. Although methanol production is quite desirable because of the large quantities of forestry and wood products available, production has not proved economical on a commercial basis. An additional consideration is that, in the long run, the immense coal resources of the United States can be utilized as a feedstock, thereby freeing additional biomass resources for conversion into methanol.

Prior to the widespread use of methanol as a motor fuel, some engine parts and fuel storage and supply components in motor vehicles must be replaced with parts which will withstand the corrosive action of methanol or methanol-gasoline blended fuel.

Methanol can be produced, along with char, oils, and gas, by pyrolysing biomass materials. If biomass is to be used as a source of methanol, the most promising technology is gasification of wood to make a producer gas. The producer gas is then made into a synthesis gas and converted to methanol. More Forest Service and SEA research is planned to improve these processes.

Chemicals

The Forest Service Madison laboratory is conducting studies on the prehydrolysis of wood with steam to extract pentosans prior to further processing. These chemicals may be used in the production of valuable co-products such as furfural and xylytol, or, in some cases, they may be fermented to alcohol with microorganisms. This type of pretreatment might also be beneficial in preparing the wood for production of high yields of glucose and ethanol from the wood cellulose, or in preparing the wood for pulping. The need for pulping chemicals is reduced by the pretreatment.

The Forest Service is conducting extensive studies on the production and characteristics of terpenes in pine extractives. These chemicals have a potential for use in internal combustion engine fuels. Turpentine was used in aviation-grade gasoline in Japan during World War II. Turpentine can be derived from pine wood as a co-product with alcohol and pulp.

The Forest Service will be examining ways for pulp mills to produce alcohols and chemicals in an integrated forest products utilization approach. Similarly, excess energy potential at wood processing plants, in the form of residue wood or co-generated low-pressure steam, could be used for distilling alcohol from grain. Rural community cooperatives might thus use either wood residues or crops as a source of sugar and heat for making alcohol.

Cooperation

There is a potential for joint efforts with other countries in pursuing production of alcohol from biomass to mutual advantage. Much work on alcohol production has been completed in Brazil, where new projects for both ethanol and methanol production from eucalyptus wood are about to begin. The United States may benefit from the Brazilian experience by working more closely with them. The Austrians and Swiss are already working with the Brazilians to pilot-test production of alcohol in a full-scale plant in Switzerland built during World War II, deactivated in 1965, and reactivated recently. Such developments should be followed.

The US Department of Agriculture Cooperative Extension Service is providing information to their county offices on the alcohol fuels programme as rapidly as technical information and loan assistance information become available. Farmers and small business in rural communities are extremely interested in examining the issues and the opportunities in producing alcohol. Initial feedback from a number of states indicates that there is more interest in community-based plant than in individual farms because of their advantages of quality and safety control and fewer storage problems.

News from IUFRO

(International Union of Forestry Research Organizations)

Acceleration in MAB-IUFRO research

The "Man and the Biosphere" (MAB) programme is now moving into its tenth year, with an evaluation of the programme's scientific progress and impact scheduled for the 7th session of the International Coordination Council. The 6th session, held at the Unesco headquarters in Paris, 19-28 November 1979, saw a marked effort made to increase research already under way under MAB auspices. A total of 52 countries were represented.

Extended discussion centred on two previous workshops co-sponsored by MAB and the International Union of Forestry Research Organizations (IUFRO). These workshops, held in Hamburg, Federal Republic of Germany, in 1977 and Djakarta, Indonesia, in 1978, concentrated on tropical rainforest ecosystems, and had recommended the standardization of research methods and the use of systems analysis. The 6th Council session in Paris in November called for an acceleration of efforts in this direction.

Scientists from several countries met informally after the session to look at possibilities for cooperation in ecosystems research under the auspices of Unesco and MAB. Two parts of an action programme for 1980 were begun: (1) E.F. Brünig, Federal Republic of Germany, will coordinate research among European scientists in tropical and subtropical forest ecosystems together with a IUFRO working party; and (2) in the area of temperate forest ecosystems, systems analysis will be done by J.N.R. Jeffers, United Kingdom, while Dutch scientists will coordinate remote sensing and grassland ecosystem research, and French participants will handle vegetation classification and mapping.

Social forest management

The subject of "multiple-use management" received strong emphasis at a symposium of the IUFRO Forest Management Planning and Managerial Economics Group at Tisens near Bolzano, Italy, during the first week of May 1979. The symposium dealt with two major themes: (1) the multiple function of forest and management planning; and (2) the inventory and management systems with special reference to Mediterranean areas.

In addition to the traditional function of wood production, social functions of forest management were stressed. Such functions include water protection, protection for scientific purposes, pollution protection, erosion control and recreation. These benefits, it was felt, can be quantified in economic terms and should therefore be included in a set of management objectives and constraints. Basic to such multiple-use planning is an inventory of forest resources. Lively discussion followed on choosing proper strategies and silvicultural systems.

Spruce stability

Recent research results have been underscoring the problem of stability of forest stands in general and spruce stands in particular. This conclusion was emphasized at a joint Unesco (MAB)/IUFRO symposium held in Brno, Czechoslovakia, from 29 October to 3 November 1979. The 49 scientists from 13 countries in attendance concluded that the MAB-IUFRO cooperation has been successful but that there is a further demand now to conduct a general survey of the facts in spruce forestry.

Increment estimation group to meet

The IUFRO working group, "Estimation of Increment," will have its next meeting during the XVII IUFRO World Congress in Kyoto, Japan, in 1981. The main theme of the meeting, "Growth of single trees," was also the theme of the group's last meeting, held in Vienna, Austria, 10-14 September 1979. Anyone wishing to be on the group's mailing list should contact the Chairman, K. Johann, Forstliche Bundesversuchsanstalt, A-1131, Vienna, Austria.

Forest history

Much activity is being generated by the IUFRO working group on forest history. First, the group held a symposium at the Ecole nationale du génie rural, des eaux et des forêts, Centre de Nancy, France, on 24-28 September 1979. The proceedings are available. Second, the group plans to report its findings to the IUFRO World Congress in Kyoto, Japan, 1981. Third, the group has set as the topic for its next symposium, in 1983, "The History of Forest Sciences." Finally, the group honoured the late M. Devèze of France, who had been the group's leader.

Two separate working groups have now been established, one, "Use and exploitation of forests," and the other, "History of forest areas and stand evolution." At the symposium in Nancy, 22 papers were presented to the first group; half were concerned with preindustrial Europe and the other half with post-industrial Europe and the evolution in North America. The central theme of the 23 papers heard by the second group was the evolution of forest policy since the time of Napoleon III.

Governments and UN agencies have begun to discuss a single policy and a division of responsibilities for control of tropical deforestation

A single broad plan for dealing with tropical forest depletion and degradation was the object of a meeting of forestry experts from governments and United Nations agencies held in March 1980 at the United Nations Environment Programme (UNEP) in Nairobi.

Beyond a plan of action, the participants discussed a division of responsibility and labour among concerned governments and international agencies. The broad objective is to arrive at an "integrated programme of activities for the conservation and wise utilization of tropical forests," according to one of the documents of the meeting. The participants represen'ed 25 governments, and four United Nations agencies, UNCTAD, UNEP, Unesco and FAO.

A consensus was reached that tropical forests must be used in a balanced way, allowing for economic and social development, but stressing environmental conservation. Neither a precise programme of action, nor funding levels were agreed upon. Presumably, this will come later. It was decided that UNEP, in collaboration with Unesco and FAO, should proceed with arrangements for a second meeting of experts to continue the talks.

Among the subjects discussed were: rain-forest research, monitoring and assessment, land-use classification and planning, training, education and public awareness, national policies, laws and institutions, agri-forestry, community forestry and ecologically sound rural development; and national parks and protected areas.

FAO's representative expressed two reservations to the meeting's "overview document". First, he said, the document did not look closely enough at the underlying causes of tropical deforestation, namely irrational agricultural development and settlement caused by uneven land distribution, increasing population and agricultural stagnation. Second, it treated exploitation as an "absolute evil," with no reference to silviculture and sustained production.

In general, however, the document's recommendations were very similar to those formulated over the years by the FAO Committee on Forest Development in the Tropics. This Committee, at its last meeting in May 1980, recommended that FAO continue to take the leading role within the UN system on matters related to tropical forestry.

Reforestation, family style

Authorities in the Serang district of West Java, Indonesia, have found a novel way to reforest the area by making couples who want to marry, divorce or remarry first plant trees. Couples wishing to marry must plant two fruit trees. Those who want to divorce are required to plant five trees, while couples wishing to remarry each other must plant three trees. The move was made to ensure that Serang continues as a major fruit-producing area of Java.

Promoting tree planting

The International Tree Crops Institute now has an Australian office. It will be run by Melbourne-based agricultural and forestry journalist, Geoff Wilson, in an honorary capacity.

Aim of the institute is to promote research, development and practical application of tree farming, agro-forestry and conservation tree-planting.

The ITCI was founded in the United Kingdom in 1977, and it has since pursued a supporting role for research into the growing of trees for food, fodder, firewood, timber, soil and conservation and other uses important to farmers and the world community.

The ice age and the Amazon

Scientists are trying to work out a conservation programme for the Amazonian rain forests of Brazil following patterns established during periods of glaciation millions of years ago.

According to a report by Earthscan, an environmental information agency supported by the United Nations Environment Programme (UNEP), birds, butterflies, trees and reptiles show distribution patterns that identify "Pleistocene refugia," or sections of the primeval forest that are much older than others.

"It seems that during the cold dry glacial periods of the Pleistocene epoch, which occurred between 2 million and 10 000 years ago, the Amazon forest persisted in fragments instead of as continuous forest," the report says. "Such fragments would have been cut off for long periods, long enough for isolated populations to evolve into many new species."

The authors of the report are Thomas Lovejoy, vice-president for science of the American branch of the World Wildlife Fund (WWF), and Maria Tereza Jorge de Padua, director of Brazil's national parks. They describe a project run by WWF and the Brazilian Government scientists that "makes the most of a Brazilian Government rule that 50 percent of the area held by each land development scheme has to remain in forest".

It is the older patches of forests, the "refugia," that would support the greatest numbers of species because it is in these areas that plants and ani-

mals would have had the longest period of time in which to evolve. Once these patches have been identified, the scientists hope to make up their 50 percent of protected forest on that basis, even if the result is a discontinuous series of reserves rather than one large tract.

TONY SAMSTAG

The Times, London

UN meeting on deforestation

International experts met in Nairobi, Kenya, 25 February to 1 March 1980, to discuss ways to slow down the rate of tropical deforestation. The meeting was convened as a result of a decision made by the UNEP Governing Council, April 1979, and was sponsored in cooperation with FAO and Unesco.

The purpose of the meeting was to adopt a plan of action to control the problem of deforestation and to decide on a division of labour and responsibility among national governments and international agencies for "an integrated programme of activities for the conservation and wise utilization of tropical forests." A consensus was reached that tropical forests must be used in a balanced way, allowing development but stressing conservation. However, neither funding levels nor a precise programme of action were agreed upon. Among the subjects discussed were: rain-forest research, monitoring and assessment; land-use classification and planning; training, education and public awareness; national policies, laws, and institutions; agri-forestry, community forestry and ecologically sound rural development; and parks and protected areas.

In its statement to the meeting, IUCN underscored the potential of tropical forests for new commodities products, food and fibre production, and genetic resources for use in applied biology. The causes and rates of deforestation, the IUCN said, vary from country to country, and governments should adopt policies for forest management and rural development that consider all the potential benefits of forests for sustainable development.

New environmental declaration

Nine international development inistitutions have now signed a "Declaration of Environmental Policies and Procedures Relating to Economic Development." Seven of them signed on 1 February 1980 at the UN headquarters in New York: the Arab Bank for Economic Development in Africa, the European Development Fund, the Inter-American Development Bank, the Organization of American States, the UN Development Programme, the UN Environment Programme and the World Bank. Two other institutions, the African Development Bank and the Caribbean Development Bank, signed later. These nine together spend $10 thousand million a year on new development projects.

Outlined in the Declaration are cooperative measures to integrate environmental policies with development. Among the principles adopted are: (1) systematic examinations of development activities being considered for financing; (2) the integration of environment and development through negotiations with national and international bodies; (3) technical assistance on environmental affairs to be given at the request of developing countries; (4) research into ways of improving the evaluation of projects in terms of the environment, including cost-benefit analyses; and (5) preparation and dissemination of audio-visual material highlighting the environmental dimension of development.

Dr Mostafe Tolba, UNEP Executive Director, said that UNEP is preparing suggested guidelines in six areas of development activity which loan institutions could use in modifying their procedures for appraising projects.

Afforestation in Indonesia

A programme of afforestation has been started on the north coast of West Java, Indonesia. Plantings of *Rhizophora, Avicenia* and *Acacia auriculiformis* are being made to serve three purposes: (1) to prevent coast erosion; (2) as a windshield from the sea; and (3) to supply fuelwood for the people. The plantings will be about 400 metres wide and will skirt the tidal forests in the Purwakarta Forest District, Cikiong Sub-Forest District and the Pamanukan Sub-Forest District.

According to the district rangers, village roads and people's yards will also be afforested. Most of this will be done with *Acacia auriculiformis* between the eight kilometre stretch from the hamlet of Pakis to the hamlet of Cibuaya. One problem, the rangers say, is that border poles are being stolen and that concrete poles may have to be substituted. People have been using the poles instead of grinding stones because stones are very scarce.

European air-pollution control

According to the Council of Europe's *Nature Newsletter*, regulations controlling air pollution now exist in every country in Europe. The EEC proposals regarding maximum concentrations of sulphur dioxide (high acidity) and particles (smoke) have not, however, been accepted by all countries. No Community directives have been proposed on industrial emissions, but each country here has its own legislation, the most elaborate being in the Federal Republic of Germany.

Expenditures on air purification equipment are roughly the same in all European countries, according to a study by the US Chamber of Commerce. During the period 1972-75, a per caput average of between US$1 and $1.70 was spent. In 1978, this had risen to between $1.40 and $2.80 per caput.

Trees damaged by SO_2

Sulphur dioxide emissions from pulp mills and oil-fired power stations can stunt the growth of pine trees, according to the results of a three-year study conducted by Mr Lars Westman of the Institute for Ecological Botany at Umea University, Sweden.

Studies conducted near one sulphate mill showed that 50 to 100-year-old trees within 500-1 000 metres of the mill suffered a 24 percent reduction in growth over the period 1946-70. Trees older than that lost 35 percent of their expected growth. Damage was observed on trees as far away as 35 kilometres.

Sulphate mills, however, were less damaging to pine trees than sulphite mills, according to Westman's study. Trees within three kilometres of one sulphite mill studied became exposed to 2 000 micrograms of sulphur dioxide per cubic metre of air. This level of exposure causes "irreparable damage" to a tree's assimilation capacity. Such emissions also caused soil acidification, resulting in a loss of 17 percent in growth over the 1946-70 time period for trees up to 12 kilometres from the mill.

United Nations agencies – environmental education for engineers

Two United Nations agencies, Unesco and UNEP, have organized new environmental education programmes in seven Latin American countries. The programmes are aimed at engineering students at universities in Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico and Venezuela.

New CO_2 action plan

Over the past century the amount of carbon dioxide in the atmosphere has increased by about 15 percent. The main causes of this increase have been burning of fossil fuels, deforestation and changes in land use. This fundamental change, according to a booklet published by the World Meteorological Organization (WMO) entitled *The world climate programme* (Geneva, 1980), "can contribute to a gradual warming of the lower atmosphere."

Now the WMO, in conjunction with UNEP and the International Council of Scientific Unions (ICSU), has recommended that an International Plan of Action be developed for the "Environmental assessment of changes in carbon dioxide levels." This recommendation was made at a recent joint meeting in Nairobi, Kenya. One of the first steps in fulfilling this action plan has already been taken, namely a joint scientific committee meeting of WMO and ICSU in March 1980 in Utrecht, the Netherlands.

Japan-US environmental meeting

Japan and the United States have very different cultural and historical backgrounds, but they are both heavily populated industrial nations with similar environmental problems. The two countries recently completed their second joint environmental conference at Stanford University and San Diego, California, 30 June to 8 July 1980. The conference brought together representatives of conservation organizations, universities, industry and government agencies for the purpose of exchanging information, comparing their environmental efforts and looking at the possibility of transferring environmental management techniques. The first bilateral conference was held in Yokohama in 1978.

The conference opened with four days of lectures, workshops and discussions on the Stanford campus. Each day focused on case studies in a particular subject area: environmental law, toxic and hazardous urban waste, rare and overabundant species, and petroleum and alternate energy sources in the eighties. There were field trips to Yosemite National Park, Mono Lake and the City of Los Angeles Water Department storage systems in the Owens Valley.

Then the conference site moved farther south to San Diego, which is Yokohama's "sister city," and case studies of deep-sea mining, coastal planning, marine mammals and fisheries.

IUCN publications

The International Union for the Conservation of Nature (IUCN) has released its 1980 publications catalogue containing 68 different items. These items are grouped in six categories: new and forthcoming publications, conservation and development, environmental policy and law, regional conservation, national parks and other protected areas, and species conservation.

One of the new publications, available for $7.50, is the *United Nations list of national parks and equivalent reserves* (1980 Edition), which is an important updated version of the 1975 worldwide list of national parks, nature reserves, biosphere reserves and World Heritage sites. There is also a comparative, 17-nation study written by Duncan Poore and Paule Gry-Ambroes entitled *Nature conservation in northern and western Europe*, which costs $17.50.

Of particular interest to developing countries are books written by Duncan Poore and William E. Odum, respectively, entitled *Ecological guidelines for development in tropical rain forests* (1976, $7.50) and *Ecological guidelines for tropical coastal development* (1976, $7.50). Also available is the IUCN's comprehensive, 4-volume *Red data book* describing all the world's threatened mammals, birds, amphibians, reptiles and fish, in addition to the companion volume *Plant red data book*, describing 250 selected threatened plants.

All inquiries should be addressed to: Bowker Publishing Co., PO Box 5, Epping, Essex CM16 4BU, England.

Ecology saint proclaimed

Pope John Paul II, who has frequently spoken out in favour of conservation, has proclaimed St. Francis of Assisi (1182-1226) the Patron Saint of Ecology. Issued on Easter Sunday, 1980, the Pope's proclamation said that St. Francis had "considered Nature a marvellous gift from God to all humanity."

TV series on the Andes

Six South American countries are jointly producing a series of 102 programmes for educational television with the title "Expedition Andina" (Expedition in the Andes). The countries involved are Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela.

The purpose of the scheduled TV series is to increase awareness of the need to preserve and develop the shared cultural values which distinguish the Andean region. Among the themes selected are: environment, housing and agriculture, arts and crafts, and pre-Colombian architecture.

Black rhino returns

The black rhino is staging a comeback in South Africa and in southwest Africa/Namibia. The animal was nearly exterminated in the nineteenth century and its numbers had dwindled to around 100 by 1930.

Three factors are credited for the resurgence. First, local national parks boards and other authorities have strictly protected the black rhino through game preserves and national parks; second, black rhinos have been re-located to safer areas in cases where they were endangered; and third, new populations have been established in appropriate areas.

Spiders replace chemicals in China

An encouraging new step toward integrated pest control management has taken place in China. Efforts by agricultural workers and researchers have resulted in the discovery of 125 species of spiders in 18 different provinces which can be used in place of chemical pesticides to control insects harmful to rice crops.

States a report by the *New China News Agency* from Changsha, in Human Province, "The use of spiders has resulted in reduction of the use of chemical pesticides, lowering the amount of chemical residue in the rice and increasing rice yields without increasing expenses."

Researchers found that if the proportion of spiders to insects is 1:20, they can destroy nearly all of the insects in a rice field within six days. Moreover, each spider can live for 1-2 years, survive for months without food and eat nothing but insects.

In 1976 spiders were used on test plots covering 23 hectares. By 1978 they were being used regularly on 73 000 hectares with uniformly good results.

Malaysian film on the environment

Another film on the environmental crisis has been made by the Consumers' Association of Penang (Malaysia). Entitled *Crisis in the Malaysian environment*, the 16-mm, 21-minute colour film highlights three villages affected by industrial pollution and land mismanagement.

Various aspects of the environmental problem are shown, in particular the country's rapid deforestation: predictions are being made that there will be no forests at all left in Malaysia by 1980 if present trends continue. Other topics presented are pollution of rivers and seas, sewage disposal, urban congestion and air pollution.

The film costs M$1 000 or its equivalent. Inquiries should be made to: Khor Kok Peng, Research Director, Consumers' Association of Penang, 27 Kelawai Road, Penang, Malaysia.

South Pacific Commission environmental education film

The first educational film produced by the South Pacific Commission has now been released after two years in production.

Story of an island: managing your island environment tells the story of a typical tropical island and how its environment changes from the original undisturbed state to the present. It shows the environmental destruction that can result from bad resource-management practices, and illustrates what this can mean for the future of the island. It also demonstrates principles of good environmental management, and tells how rural islanders, both young and old, can work to protect village resources.

The film is intended for rural adult and youth audiences in the Pacific Islands, but it could also be useful in other island areas with similar conditions. It may be used in conservation programmes, in agricultural, forestry and fisheries extension activities, and in school programme. The editing and narration were designed to be easily understood by rural audiences. The film was made by Island Image Productions Noumea, for the South Pacific Commission, using footage shot in Western Samoa, New Caledonia and the Loyalty Islands. It shows fishing, gardening, and other resource use, as well as problems like erosion and water pollution. Logging is used as an example of major development projects. The actual scenes showing different Island peoples are mixed with views of a model island which goes through many stages from virgin purity to total environmental collapse or sustainable resource management.

The film is intended to raise questions and to encourage discussion more than to provide specific answers (which local people should do for themselves). It aims to help people re-examine their present use of resources (land, sea, water, plants and animals), and to think about the direction development is taking on their island.

This is a 16-mm colour film with optical sound track in English or French and is 45 minutes long. Prints are being given by SPC to each country in the area for which SPC works. Copies are also available on loan within the SPC area from the Librarian, South Pacific Commission, Noumea. Prints may be purchased from SPC at cost, at present CFP 25 000 (A$300), or less if more than one print is ordered at a time. A written script is available with the film so that a narration can be arranged in local languages.

BOOKS

A slower-growing world

Facing the future: mastering the probable and managing the unpredictable. Organisation for Economic Co-operation and Development, Washington, D.C., USA, 1980. 426 pp. Price: $20.00.

Economic growth can no longer occur at the historical 1945-73 trends, according to this survey by a study group of the Organisation for Economic Co-operation and Development (OECD). Scenarios for possible futures are developed in terms of trade, monetary, and income infrastructures. The overall assessment of future economic growth is optimistic, but social and environmental problems are clearly spelled out and the book warns of the lack of political will to address crises.

A good survey is given of trends that endanger the economies of both industrialized and developing nations. With regard to Third World development strategies, attention is given to the need for strong agricultural sectors combined with good soil conservation programmes; to the transfer of technology; and to creative initiatives industrialized nations might make toward developing ones.

African future

Environment and development in Africa. United Nations Environment Programme and the Environment Training Programme (ENDA)/Pergamon Press, Oxford, England, 1980. c.100 pp. Price: c. $14.00.

This soon-to-be-released book is a UNEP study of the future prospects for African development within an environmental framework. The book analyses specific components of this topic such as population increase, food supply, health, urbanization, industrialization, economics, technology, agricultural production, deforestation and desertification.

Monitoring forests by satellite and computer

Monitoring forest canopy alteration around the world with digital analysis of Landsat imagery. Edited by D.L. Williams and L.D. Miller, Greenbelt, Maryland, USA. National Aeronautics and Space Administration, Goddard Space Flight Center, 1979. Softcover pamphlet with colour and black-and-white photographs. 45 pp.

Satellite remote sensing of forest ecosystems has moved from detection and identification to monitoring. The result, this pamphlet's editors conclude, will be to improve the forest management process by closely following alterations in the forest canopy caused by shifting cultivation, tropical forest exploitation, insect infestations and natural canopy closure.

Seven different case studies are included, all of which were at least partially conducted and written by one or both of the editors, D.L. Williams and L.D. Miller. Included are: (1) alterations of forested watersheds in the Republic of China; (2) exploitation in the central Nigerian forest reserves; (3) exploitation on the Haiti-Dominican Republic border; (4) canopy closure in the pine forests of North Carolina; (5) insect defoliation in Pennsylvania; (6) forest site-index mapping in Colorado; and (7) shifting cultivation in northern Thailand.

Conservation in Zaire

Aspects de la conservation de la nature au Zaïre, by Dr. Kabala Matuka. Editions Lokole, Kinshasa, Zaïre, 1976. 312 pp.

With special attention to Zaïre, Dr. Kabla Matuka's book addresses itself to three fundamental principles of conservation: the need for rational utilization of resources; the development of the concept of conservation; and the degradation of the environment, emphasizing the laws which govern Nature's delicate balance. (French only)

Educational materials

A publication and price booklet, updated as of April 1980, is available through the British Paper and Board Industry Federation. Educational materials include books, papers, leaflets, charts, video-cassettes, tape/slide presentations and reference and text books.

Some of these might have particular value for developing countries. For example, there is a series of 28 self-instruction packages for education and training entitled *The paper- and board-making process.* This is available, together with a tape/slide presentation for schools entitled *Paper.*

Other relevant items include a *Paper* booklet suitable for children, a handbook of paper projects, a large chart (free) describing how paper is made, energy and water-saving checklists, a calculations booklet, as well as such specific, technical materials as *An operator's guide to aqueous coating.*

All inquiries should be directed to: Information Department, British Paper and Board Industry Federation, 3 Plough Place, Fetter Lane, London EC4A 1AL, England.

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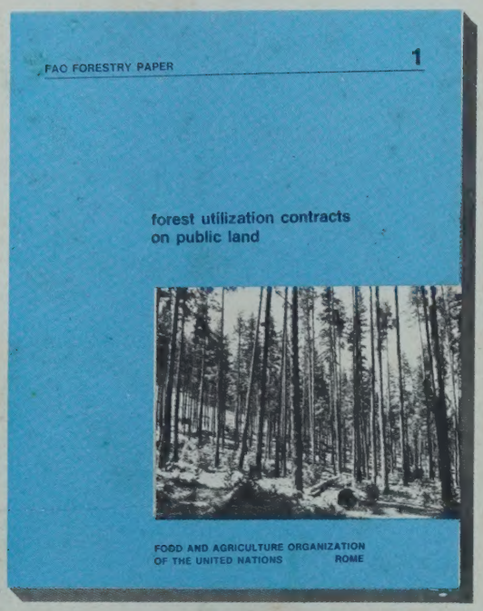
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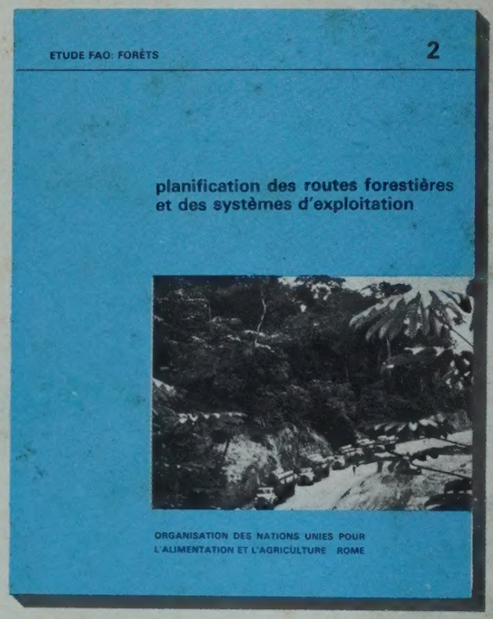
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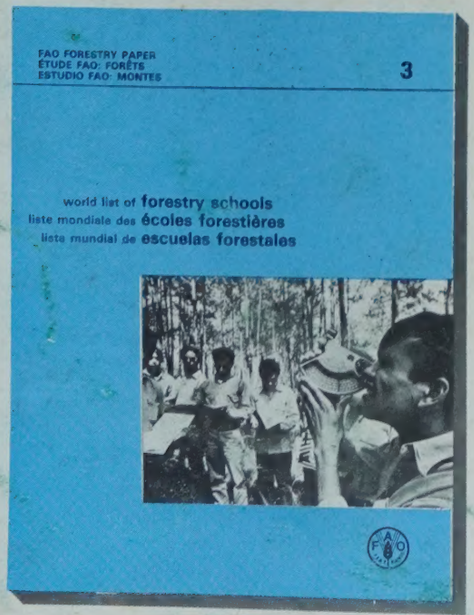

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